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VOL. CLIII.—No. 3973] LONDON: FRIDAY EVENING, MARCH 4, 1932 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES.

TO CONTRACTORS ONLY.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 17th March, 1932, for the SUPPLY of—
(1) ELECTRICAL.
(2) MECHANICAL.
LABOUR in DAYWORK in the Birmingham (Mechanical only), Bristol and Liverpool districts during the period of three years from the 1st April, 1932.
Forms for Tender, &c., may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1. 8236

County Borough of Sunderland.
DEEP-WATER QUAY.—CONTRACT NO. 5.
TO CONTRACTORS.
The Corporation of Sunderland are prepared to receive TENDERS for the SUPPLY and ERECTION of a BELT CONVEYOR for loading coal into ships, and other works in connection therewith, upon a site on and adjoining the new Deep-water Quay on the River Wear at Sunderland, County Durham.
The contract documents may be seen upon application to the Engineer for the scheme, W. H. S. Tripp, M. Inst. C.E., c/o River Wear Commissioners, St. Thomas-street, Sunderland, or may be obtained from him on payment of a deposit of Five Pounds by crossed cheque, which will be returned on receipt of a bona fide Tender accompanied by the whole of the documents issued.
Tenders, which will only be considered if made upon the form supplied, must be completed in accordance with the detailed instructions incorporated in the documents, enclosed in a sealed cover, endorsed "Tender for Deep-water Quay, Contract No. 5," and delivered at the office of the undersigned, Town Hall, Sunderland, not later than Noon on the 9th May, 1932.
The Corporation do not bind themselves to accept the lowest or any Tender.
H. CRAVEN,
Town Clerk.
Town Hall, Sunderland,
22nd February, 1932. 8199

Manchester Corporation.
The RIVERS COMMITTEE invite TENDERS for the CONSTRUCTION of the following WORKS:—
WYTHENSHAWE DRAINAGE.
(1) LONGLEY-LANE SEWER (1st Section), in Moor End and Longley-lane, from Palatine-road to Beech-avenue.
(2) EASTERN INTERCEPTING SEWER (2nd Section), along Princess-road Parkway and Proposed Road, from Junction Chamber near Wythenshawe-road to Woodhouse-lane.
Plans may be seen and specifications, bills of quantities and forms of Tender obtained on application at the City Engineer's Office, Town Hall, Manchester, upon payment to the City Treasurer of £5 5s. FOR EACH WORK RESPECTIVELY, which sum will, after the Corporation have come to a decision upon the Tenders received, but not before, be returned to the persons submitting bona fide Tenders.
All cheques or postal orders are to be made payable to the order of "The Corporation of Manchester."
Tenders, enclosed in the official envelope and addressed to "The Chairman of the Rivers Committee," are to be delivered at the City Engineer's Office not later than 10 a.m. on Thursday, the 17th March, 1932.
The Corporation do not bind themselves to accept the lowest or any Tender.
F. E. WARBRECK HOWELL,
Town Clerk.
Town Hall, Manchester,
29th Feb., 1932. 8224

North Kesteven Rural District Council.
WATER SUPPLY TO EASTERN AREA.
PUMPING INSTALLATION.
The above-named Council invite TENDERS for the SUPPLY and ERECTION of DUPLICATE PUMPING MACHINERY at the New Pumping Station at Waneham Bridge, Metheringham.
Each set, consisting of Multiple-stage Turbine Pump, lifting 9000 gallons hourly a gross lift of 354ft., and a Centrifugal Pump lifting 4500 gallons hourly a gross lift of 114ft., both pumps being driven by Crude Oil Engine through Countershaft.
Full particulars may be obtained from the Consulting Engineers, Messrs. Elliott and Brown, Chartered Civil Engineers, Burton Buildings, Parliament street, Nottingham, and a copy of the specification and plan on deposit of Two Guineas (by cheque), which will be returned on receipt of bona fide Tender and return of documents.
Tenders to be sent to the undersigned not later than first post on Friday, March 11th.
The lowest or any Tender not necessarily accepted.
By Order,
ROBERT EPTON,
Clerk to the Council.
2, Bank-street, Lincoln,
February, 1932. 8209

Egyptian Government.
MINISTRY OF PUBLIC WORKS.
The Central Administration of the Egyptian Ministry of Public Works invites APPLICATION for the POST of DREDGER MASTER for service in the Sudan in charge of a modern 2 c. yard Dipper Dredger.
The following qualifications are essential:—
Board of Trade 2nd Class Marine Engineers' Certificate.
Five years' experience of dredger operations, of which two years in charge; not more than 40 years of age.
The contract will be for 2 years (renewable).
The pay will be £E240 p.a. (£E equals £1 0s. 6d.) plus 40 per cent. Sudan allowance and single quarters will be provided on the dredger. Pay and allowance will be subject to Government Stamp Duty.
The appointment is subject to medical examination and approval of the Authorities in Egypt.
The selected candidate will be granted a transfer allowance equal to one month's salary for change of residence from England to Egypt and vice versa.
Third-class fares and reasonable out-of-pocket expenses will be paid to applicants who are requested to attend for interview and/or medical examination.
Application and specimen contract forms may be obtained from
THE CHIEF INSPECTING ENGINEER,
Egyptian Government,
41, Tothill-street, London, S.W. 1,
to whom they should be returned with full particulars as to education, qualifications, previous experience, personal references, and COPIES of certificates of testimonials.
Applications to be received here by 18th March, 1932.
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The Engineer

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Required, Electrical Engineer and MANAGER, for Aden Settlement Electricity Department, Aden, Arabia. Must be sound, practical Engineer with special experience in Repairs, Renewals, and Maintenance of High-speed Geared Turbines, Water-tube Boilers, Auxiliaries, &c., and conversant with High and Low-tension Distribution and Electrical Apparatus. Must be efficient, abstemious, responsible, and capable of taking full control.
Applicants should apply to the Chairman, Aden Settlement, stating age, married or single, when available, enclosing references and full particulars of experience from school to date, also enclosing recent photograph.
Only those with necessary experience and qualifications need apply.
Terms: Preliminary three years' agreement, with view to permanency. Salary, Rs. 800, rising by yearly increments of Rs. 50 to a maximum of Rs. 1000 per month, plus Rs. 50 travelling allowance, free unfurnished quarters, electric light and water, leave allowance three months on completion of first agreement, additional three months if re-engaged.
First-class B passage British India or equivalent out and home on completion of first term. 8163

SITUATIONS OPEN.

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN THIS CLASSIFICATION.
For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge and co-operation is asked for.

LEYLAND MOTORS, Ltd., REQUIRE the SERVICES of a practical MECHANICAL ENGINEER with first-class technical qualifications as Assistant Technical Instructor to the Company's Establishment for the training of Student Apprentices.
Those desirous of applying for this position must apply to the PUBLICITY DEPARTMENT, Leyland Motors, Ltd., Leyland, Lancashire, for the necessary application form. 8240 A

YOUNG ENGINEER REQUIRED as Assistant to Departmental Manager in factory 60 miles from London; should have had good general education and experience in managing men. Age 25-30. Starting salary, £200 per annum.
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SITUATIONS OPEN (continued)

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DRAUGHTSMAN, not Under 40, Married, Tall, of good address, to TAKE CHARGE of D.O. of Company processing Clinker, i.e., Coal Residues. MODERNISATION of PLANT to be undertaken.
Capacity for continued meticulousness on modern design of paramount importance. Must have been in receipt of £312 p.a. Salary £468 p.a. under Agreement. Promotion according to delivery.
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CHIEF ENGINEER, A.M.I. Mech. E., M. Am. Soc. M.E., experienced in modern American high-tonnage mining and chemical plants, construction and operation, fluent Spanish, expert organiser and administrator, DESIRES RE-ENGAGEMENT.—Address, P2142, The Engineer Office. P2142 B

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The Engineer

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P2143 I

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A Seven-Day Journal

South-East London Technical Institute.

LAST Friday the new South-East London Technical Institute in the Lewisham High-road was opened by Sir John Gilbert, Chairman of the Education Committee of the London County Council. The opening of this Institute is the result of a very careful review by the London County Council over a long period of the need for additional facilities for technical education in South London. The building consists of three floors and a basement. Designed and equipped on modern lines, it has cost about £134,000, and is one of the largest educational institutions built by the Council. There are separate departments for engineering and building, and a women's department. Accommodation is also available for a girls' trade school and a boys' junior technical school in engineering, but the opening of these schools has been postponed owing to existing financial and industrial circumstances. The Institute caters mainly, therefore, for students over seventeen years of age, and the installation in the numerous workshops and laboratories of up-to-date plant of British make, including experimental equipment and testing apparatus, makes it possible for the instruction to be carried to an advanced stage. The Institute is intended, in short, to meet the educational requirements of persons actually engaged in present-day industry, and an excellent start has already been made in the evening departments. Practical and theoretical instruction is given in mechanical and electrical engineering, building construction, workshop and machine tool practice, plumbing, carpentry and joinery, metal plate work, and gas supply. Technical classes are also held for Post Office engineering workmen.

British Standards Institution.

IN connection with the visit of Mr. C. le Maistre, Director of the British Standards Institution, who has been sent on a mission at the request of the Board of Trade to Australia, New Zealand and Canada, a telephone conversation with him took place last Tuesday by wireless between Wellington and London. During this conversation he stated that at a fully representative meeting that morning in Wellington, it was decided to set up a New Zealand Standards Organisation. Mr. G. W. Forbes, Prime Minister of New Zealand, authorised Mr. le Maistre to state that not only was he personally very sympathetic to that development, but, on the advice of his officers, he was satisfied that the Mission from the British Standards Institution had been most successful. He felt that it would prove of material assistance in organising the new Standards Body of New Zealand, and establishing intimate relations with the national standardising organisation in London. Mr. le Maistre also reported that during his visit to Australia he found that there, also, the advantages to inter-Imperial trade of the co-ordination of national specifications within the Empire were fully appreciated, Mr. Bruce emphasising particularly the essential need of a central advisory committee in London to assist in this co-ordination and to form a link between the Home Country and the standards organisation in the Dominions.

An Arctic Air Route.

LAST Tuesday a Bill was introduced into the Icelandic Parliament to authorise the Minister of Communications to grant a concession to the Trans-American Air Lines Corporation, by which an air service for passengers and mails from Detroit to Copenhagen *vid* Iceland would be maintained. The Bill passed its first reading, and it is stated that it is likely to become law. The main points in it are:—the concession to the Corporation of the sole right to fly over Iceland as far as flights to and from the United States are concerned; the rights of inland flying, presumably including the establishment of aerial services over the country so long as no national company is formed for the purpose; the erection of an air port at Reykjavik and, later, if required, at other suitable sites, and the establishment of wireless stations in the interests of aerial navigation. According to the terms of the Bill, the Corporation would have the monopoly of flights to America for fifteen years, and the other concessions would remain in force for seventy-five years; but all the rights granted would be subject to cancellation if a regular Transatlantic service was not established by 1936. We understand that if the service is put into operation the seaplanes used will be fitted also with skids. So fitted, the machines will be able to land, in case of emergency, either on ice or the open sea.

The Shipbuilding Employers' Federation.

A CONFERENCE between the Shipbuilding Employers' Federation and shipyard trade unions was held last Friday at St. Pancras Station Hotel, London. In a statement issued by the Federation to the delegates a proposal was put forward that a small joint committee should be set up to examine the case for revising the payments under the national overtime agreement in relation to the circumstances existing in the industry. Reference was made to the important question of facilities and interchangeability. It was pointed out that restrictions on the employment of men or of tools and on the interchangeability of classes of workers affected repair work costs to a very serious extent. The suggestion was made that on this question also, a small committee might be appointed rather than that it should be discussed in a big conference. It was known how vital in a matter of that kind was the co-operation of the executives, and how great was the influence they could exert on the attitude in which those questions were approached in the establishments and districts. Referring to the rule under which, after a general wages settlement, there should be no further general wages claims put forward on either side for a period of six months, the statement made it clear that the Federation considered that none of the points raised came within that exclusion. In no case were wages in the general sense of that term affected by any of the items. Even should there be any doubt on the point, the delegates were to be reminded that the matters raised were part of the original proposals referred to in April as matters for discussion.

The Measurement of Ships.

A FURTHER step towards international uniformity in ship measurement has been taken by the publication of draft regulations for tonnage measurement by the Technical Committee on Tonnage Measurement, which held its meetings at Folkestone last year. These three documents, which are published by Allen and Unwin, of London, for the League of Nations Organisation for Communications and Transit, deal in draft form with the supplementary report of the Committee, the rules for both external and internal measurement, and the determination of gross and net tonnages. With the report on the findings of the Committee there are issued draft formulæ of measurement along with tonnage certificates, which, in the opinion of the Committee, will serve to guide usefully the application of the international regulations. The draft provisions only take into account those ships existing at the time of the coming into force of the international regulations. Ships already measured according to the so-called English system of tonnage measurement need not be re-measured, but those otherwise measured will require to be re-measured according to the international regulations within five years of the coming into force of such regulations. When an agreement has been reached between the various Governments with regard to the international regulations and their application, the Committee suggests that the transitory provisions it has now drafted can usefully be incorporated in any such agreement.

Electricity in Industry.

SPEAKING at a luncheon arranged by the Electrical Advisory Committee at the Birmingham British Industries Fair on Wednesday last, the Minister of Transport, Mr. Pybus, said that in a large number of industries electrical plant now operating, and dating from 1924 and subsequent years, constituted between 40 and 70 per cent. of all the plant in existence; in other words, a very large percentage of all the electrical equipment in industry was not more than seven years old. Those figures, admittedly estimates, were indicative of an enormous industrial effort which had not been properly appreciated. Taking iron and steel alone, in 1931 the peak capacity of the main mill motors was over 900,000 horse-power, the annual increase being over 100,000 horse-power. There were iron and steel plants in the country which were the most advanced of their kind in existence. The same remark applied to coal mining, paper, textiles, and almost every industry of importance. The National Power Scheme had served as a great advertisement for British engineering skill, and it was receiving the closest attention by economists and statesmen in other countries, who were studying the problem of national reconstruction. The interest taken in the "grid" had served to strengthen confidence in British capacity to carry out important experiments and to meet the varying conditions of modern industrial competition. The construction of the "grid" had given British manufacturers experience in the most extensive overhead transmission systems operating at high pressures. They had also obtained valuable experience in the manufacture of high-pressure, oil-filled cables, in the development of heavy outdoor switchgear, and in the provision of sub-stations.

Railway Electrification.

IN an address delivered at the City of Birmingham College, Sir Philip Dawson explained that the electrification of railways would not only mean an expenditure which would materially help industry, but would also bring considerable traffic to the railways, and when completed would give them greatly enhanced facilities for dealing with every form of traffic. With the exception of the Southern, the railway companies did not favour the idea, and were straining every nerve to stop progress instead of encouraging it. They had not altered the attitude condemned in the final report of the Royal Commission on London Transport, issued last year, which stated that "the general attitude of the companies seemed to have been that a passenger had to use a particular line, and that he must travel at times and at speeds convenient to the company." Wherever electrification of suburban railways had been carried out, the financial results had been satisfactory. As regards main line electrification, although there might be slight increases in the receipts and improvement in the service, the main object was to reduce operating costs to such an extent as would show a satisfactory return on the additional capital involved, and enable railways to reduce charges and improve services, with a view to meeting the ever-increasing road competition. As a result of electric tramway and road motor transport competition, railways had been steadily losing traffic on their suburban systems, but experience had shown that if the average speed of the trains was high and the interval between them small, so that passengers did not have to worry about time-tables, the railways not only regained their lost traffic, but an entirely new traffic was created. That the adoption of such methods paid was more than proved by the results achieved by the Southern Railway, which had practically completed the electrification of the whole of its suburban system, and was extending as far as Brighton and Worthing.

High-speed Oil Engine Progress.

ABOUT a year ago an "omnibus" meeting was arranged by the Institution of Automobile Engineers, in which eleven different societies and institutions gathered to hear and discuss a paper by Dr. S. J. Davies and Mr. E. Giffen on "Injection, Ignition and Combustion in High-speed Oil Engines." On Tuesday evening last, another such meeting, also arranged by the Institution of Automobile Engineers, and equally, or even more, successful, was held in the Caxton Hall, Westminster, to hear and discuss a paper by Mr. C. B. Dicksee, of the Associated Equipment Company, Ltd., of Southall, on "Some Problems Connected with High-speed Compression-ignition Engine Development." Mr. Allan Chorlton presided over a meeting of some 550 members and friends, and a valuable discussion followed. Several members had accepted the invitation of the A.E.C. to inspect at its Southall garage the same afternoon heavy-oil-engined transport vehicles of the A.E.C., Karrier and Armstrong-Saurer types, which were afterwards put through their paces on Harrow Hill. Mr. Dicksee's paper deals fully with the very thorough experimental work which has been carried out on the A.E.C. high-speed C.I. engine, and discusses such subjects as the utilisation of the air, compression ratios, and compression temperatures, the process of combustion, the delay period, and fuels and engine knock. It was highly esteemed by all speakers as forming a definite contribution to the development of the high-speed C.I. engine. Several speakers and the author put forward a plea for closer co-operation between engine builders and oil producers with a view to deciding the best types of fuels for transport vehicles and other uses. The evening was well spent, and the chairman expressed the hope that next time more papers might be discussed.

The Institution of Civil Engineers.

THE annual dinner of the Institution of Civil Engineers was held on Wednesday, March 2nd, at the Savoy Hotel, London. On the whole, the change from the custom followed in past years of holding the dinner in the Institution's own building in Great George-street seems to have met with approval. The number of members and guests attending the dinner, some three hundred and twenty, was greater than for some years past, and as Mr. E. F. C. Trench reminded us, the choice of a meeting place in the Strand was in the nature, not so much of an innovation, as a reversion to the custom of the founders of the Institution, who, a hundred years ago, were wont to assemble in a coffee house in that historic thoroughfare. The dinner and the speeches which followed it were alike excellent. Lord Macmillan, an honorary member of the Institution, in proposing the toast of "His Majesty's Ministers," dealt with the opportunities and responsibilities of the Government. We were, he said, in the midst of one of those cyclic changes which seemed to take place every two or three hundred years in the history of most nations. The changes occurring connoted, not decay, but growth. Sir E. Hilton Young, responding, dwelt upon the water, sanitation, and other works of the engineer which had promoted the health of the people, and paid a warm tribute to the engineering inspectors working under him at the Ministry of Health. The High Commissioner of Canada, Mr. G. H. Ferguson, proposing the toast of "The Institution of Civil Engineers," said that there was no country in the world which offered greater opportunities for engineers than Canada. The population numbered ten million and had inherited a potential supply of forty million horse-power from natural resources, of which only six million had so far been utilised. Already Canada had made herself the fifth trading nation of the world. Sir Cyril Kirkpatrick responded to the toast and was followed by Mr. E. F. C. Trench, who proposed "Our Guests," to which the French Ambassador and the Dean of Westminster replied.

Models and Analogies for Demonstrating Electrical Principles

By ARTHUR H. DOUGLAS, M.C., M.A., A.M. Inst. C.E.

READERS will, perhaps, remember that a series of very interesting articles under the above heading was published in THE ENGINEER between July and December, 1926. At the time, the author was unable to contribute the information given below, as he was then engaged on up-country work in the Far East. Having lately devised a few elementary applications in connection with wireless circuits, however, he felt that the method might prove of sufficient topical interest to warrant belated publication, especially as it possesses several distinctive features not shared by any of the analogies hitherto described. In fact, the term analogy is, perhaps, hardly a fair one by which to describe the models illustrated below, the equations of whose motions are in most respects mathematically identical with those of the corresponding electrical apparatus. It is not proposed to introduce any mathematics into the present article, but those interested in this aspect of the subject are referred to the late Professor Perry's "Calculus for Engineers,"[1] and similar works. In plain language the above statement means that changes in electrical conditions can be faithfully reflected in the mechanical conditions of the corresponding model, even in the case of such electrical conceptions as mutual induction and its derivatives, where the well-known "water analogy," for example, breaks down entirely.

GENERAL.

Briefly, the models are built up from mechanisms exhibiting the following reactions and qualities, against each of which is placed its corresponding electrical equivalent—and mathematical counterpart :—

Torque	Voltage
Rate of revolution	Current
Fluid resistance*	Electrical resistance
Resilience	Capacity
Moment of inertia	Inductance
Moment of momentum	Magnetic flux
Centrifugal force	Magnetic attraction
Gyroscopic torque	Magnetic torque

* Or Eddy current resistance; see Perry's "Calculus for Engineers," page 168.

The desired reactions are effected with the aid of the following mechanical links, against each of which is again placed its electrical equivalent :—

Single length of shafting	Electric circuit
Weight operating drum	Battery
Prime mover	Dynamo
Clutch	Switch
Spiral spring	Condenser
Fly-wheel	Coil
Reversing gear	Commutator
Free-wheel	Rectifier
Safety coupling	Fuse
Escapement action	Make-and-break
Differential drive	Circuits in parallel
Governor mechanism	Magnetic attraction of coil
Sun and Planet gearing	Transformer coupling
Gear ratios to S. and P. shafts respectively	Numbers of turns in transformer coils
Proportion of total M. of I. on Planet shaft	Degree of coupling

Some of these analogies are doubtless familiar to readers, having already been described by Dr. Drysdale and other writers.[2] Others are, to the best of the author's belief, original, though it must be confessed that he has not found time to make an exhaustive study of the available literature on the subject. For this reason, his ideas are put forward with some diffidence, and are intended rather as an invitation to more fertile minds, than as an authoritative statement on the subject.

The application of these mechanisms will now be illustrated by applying them to a few elementary circuits selected from telephone, power, and wireless engineering respectively. Before doing so, the author would like to draw particular attention to the fact that many, if not most, of the mechanisms shown lend themselves to practical construction as continuously working models—a feature which he thinks will appeal to the engineers amongst his readers, and which is in sharp contrast to many of the existing electrical analogies. The author is aware that the use of technical models is still looked upon by many as a sign of mental weakness, but feels he is in good company in pleading guilty to this form of amusement. After all, the engineer is—or should be—a visualist by training.

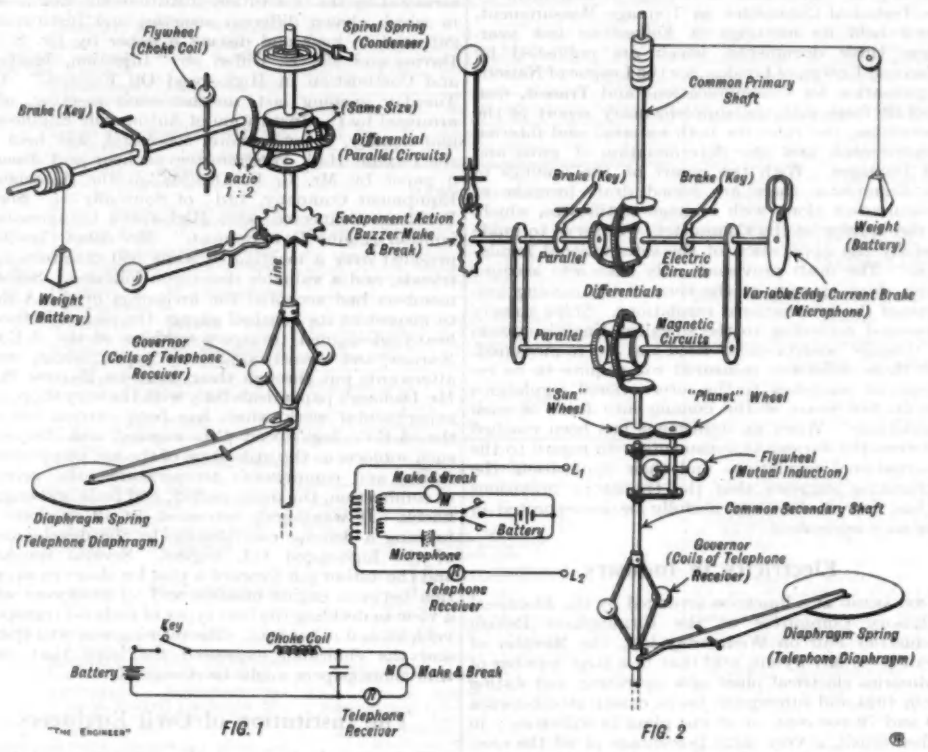
ELEMENTARY TELEPHONE CIRCUITS.

The circuit illustrated in Fig. 1 is an elementary form of that used in the old Army "Fullerphone," an instrument designed during the late war to utilise small but steady line currents from a Morse key, which could not be picked up by the enemy listening apparatus, as could the fluctuating current from a buzzing telephone. Inside the receiving portion of the instrument, the steady current was converted into a buzzing current by the method shown in the circuit diagram on Fig. 1, in order to actuate a telephone receiver, the signals being too weak to operate any form of key. Though the telephone itself is probably now out of date, the circuit shown is fundamentally similar to the standard forms of wireless coupling, as shown in Fig. 10. No time will be wasted in elaborating this simple analogy, except to draw attention to the relative sizes of wheels in the differential gear, which must be as shown in order to reproduce correctly the electrical effects. A student turning the handle of such a machine should not long remain in ignorance of the functions of the spring and fly-wheel in preventing the "kick" from working its way back to his wrist. The operation of the "telephone receiver" will be referred to later.

A more complicated example is shown in Fig. 2. This represents the complete circuit of the old Army "D. III." telephone, which played no small part in helping to win the war of 1914–1918. The author has selected it as an effective illustration of the use of Sun and Planet motion to imitate mechanically the mutual inductive effects between primary and secondary coils, combined with the use of parallel electric and magnetic circuits. Fig. 2 shows the whole inductive effect concentrated in the Planet shaft; in other words, the degree of coupling is a very close one, as is usually the case in ordinary telephone and power engineering. In wireless engineering, as we shall see later, the required degree of coupling varies widely. This variation can easily be reproduced mechanically by varying the proportion of the total Moment of Inertia which is carried on Primary, Planet, and Secondary shafts respectively, so as to keep the self and mutual inductances of the Primary and Secondary—as defined below—at their correct values. Further reference is made to this aspect of mutual induction, in connection with dynamo and motor analogies. It is obvious that a constant speed of rotation in the Primary shaft will produce no effect on the Secondary, whereas a steady alteration of its speed will cause the Planet wheel, in resisting the change of motion, to "walk" round the Sun wheel, and thus produce a steady speed in the Secondary shaft.

In order to appreciate the application of the transformer analogy of Fig. 2 to the more complicated case of the electric dynamo and motor, it will be necessary to study its action in some detail. Neglecting the inertia of the Planet shaft as a whole with respect to the secondary shafting—a point which will be dealt with later—the primary and secondary inertia effects are completely interchangeable, and are also capable of being added or subtracted. A simple illustration of this is given in Fig. 3 (*a*), where the gear ratios between the Primary, Sun, and Planet shafts are both unity, while both Primary and Secondary shafts are subject to a common drive in a clockwise direction. In fact, Fig. 3 (*a*) is a model of an electric coil, consisting of two turns. Fig. 3 (*b*) shows the effect of adding a third turn to the coil. The moment of momentum (magnetic flux) is evidently proportional to (No. of turns) × (common current). If now the current in the middle turn be reversed—as shown in Fig. 3 (*c*)—the magnetic effects of the first two turns cancel out, and the final moment of momentum is that due to the third turn only. Instead of building up the complicated and impractical mechanism shown in Fig. 3 (*b*), however, we can achieve the same object by making the gear ratio between the first two shafts, or between the second two, equal to 2, and using a single Planet wheel, as shown in Fig. 3 (*d*). In the general case, as shown in Fig. 3 (*e*), the gear ratio between Primary and Sun shafts is equal to N/1; that between the Secondary and Planet shafts is $n/1$; while the Sun and Planet ratio is unity; where N and n are the number of turns in the primary and secondary coils respectively.

The coefficient of self-induction of a coil is defined as the resisting torque—back e.m.f.—produced by unit rate of change of speed—current. But unit rate of change of velocity in the Primary shaft produces N times that rate in the Sun and Planet shafts, and therefore a proportional resisting torque in those shafts due to inertia. The same gear ratio, however, gives this torque a mechanical advantage of N in transmitting it back to the Primary shaft, so that the torque on the latter—*i.e.*, its coefficient of self-induction l—is equal to N^2I, where I is the moment of inertia of the Planet shaft round its own axis. Similarly, the coefficient of self-induction l of the Secondary shaft is n^2I, and therefore their coefficient of mutual induction $m = D\sqrt{L\,l} = N\,n\,I$, assuming D (Degree of



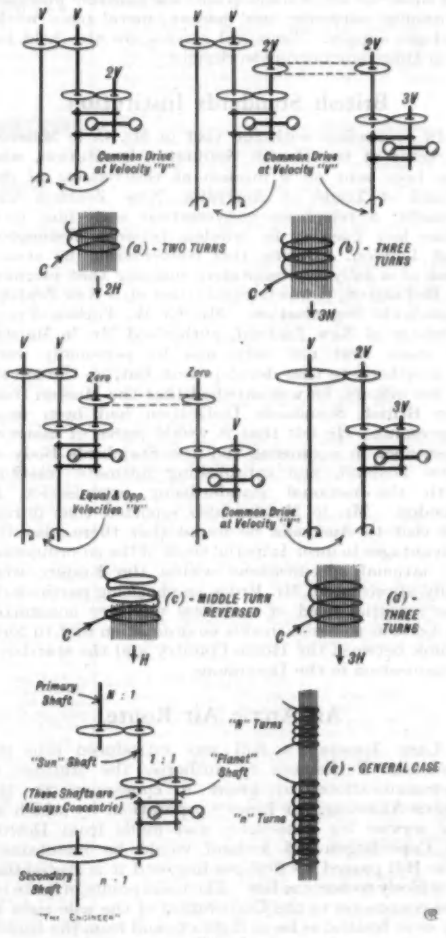


FIG. 3

[1] Pages 156, 168, 210 to 213, 254 *et seq.*

[2] See previous articles in THE ENGINEER, referred to in the first paragraph.

coupling) is 100 per cent., as in the present case. It should be noted here that any slip which occurs between the Sun and Planet wheels represents a loss of magnetic energy, followed by its conversion into frictional heat. Thus hysteresis effects can be roughly reproduced, by arranging for slipping to occur at and above a certain critical speed, which will correspond with the magnetomotive force producing saturation in the transformer core. This point is referred to again, in connection with wireless coupling circuits.

Elementary Dynamo and Motor Circuits.

Attention has already been drawn to a flaw in the transformer analogy as illustrated in Fig. 2, caused by the fact that the Planet shaft has a double moment of inertia with reference to the Secondary shaft, namely, that which is common to both primary and secondary circuits, and that of the Planet shaft as a whole—*i.e.*, apart from its own revolution—with reference to the Secondary shaft. This latter inertia is not common to both shafts, and therefore constitutes a form of magnetic leakage which appears at first sight to be inseparable from the type of mechanism adopted. From a theoretical point of view, this could easily be remedied by assuming the actual centre of rotation in space to coincide with the Planet shaft instead of the Sun shaft, and the rest of the mechanism, if necessary, to move round this new pivot. In the telephone model, however, it was thought better to stick to the more convenient mechanical form. In the more complicated cases now to be considered, the same procedure will be adopted, as it does not affect the general conclusions. The fact just referred to, that a single body in rotary motion can have more than one kind of active inertia, is utilised later to illustrate in a purely mechanical model the working of the electrical dynamo and motor.

It will be noticed that Figs. 1 and 2 illustrate two distinct methods of utilising the well-known property of inertia for the diversion of energy from one path to another. In Fig. 1 the tendency for matter to move in a straight line—in other words, its inertia of translation—is made use of in the form of "centrifugal force," to move a diaphragm up and down against its own elastic resistance, by means of a "governor" type of mechanism, thus reproducing the action of a telephone receiver. Quantitatively, this centrifugal force $\propto m\,\omega^2\,r$, where m is the fly-wheel mass (of the governor weights), r its radius of rotation, and ω the speed of the shaft. In the more general case, $F \propto m\,n^2\,\omega^2\,r$, where the shaft is geared up $n/1$ to correspond with the number of turns in the corresponding electric coil. It can be shown that the governor link l converts this into a pull of $m\,n^2\,\omega^2\,\sqrt{l^2-r^2}$ along the shaft. If r is small compared with l, then P, the pull along the shaft, $\propto m\,n^2\,\omega^2$. Now the corresponding magnetic force $= a\,n^2\,c^2$, where a = area of coil. Thus a is represented in the mechanical model by m, the fly-wheel mass. It should be noted that this type of motion involves changes in the active moment of inertia of the shaft, corresponding to changes in the magnetic reluctance of the electric machine, which property is inversely proportional to it. This is another way of stating that centrifugal force corresponds to magnetic attraction, and motion caused by it, to mechanical motion of the electric machine.

Fig. 2 illustrates an alternative method of utilising the property of inertia. Here centrifugal forces are all suppressed, and the only change of motion possible is in rate of rotation. By means of a "sun and planet" mechanism, the resistance of matter to rate of change of rotary motion can be utilised to transmit energy from one shaft to another, by what may be termed "fly-wheel action." In this case, no change takes place in the moment of inertia, as it illustrates a purely electro-magnetic reaction, namely, that of an electric transformer. Fig. 3 shows that the transformer analogy can be used to apply the integrated energy from any two circuits, to a third acting in the same plane.

We now come to the more general case of interchange of motion between three shafts which are not in the same plane. Here we make use of a combination of two forms of rotational inertia in different planes, to produce a "gyroscopic torque," in a third plane normal to both the others. In other words, the interaction between two electrical motions and one mechanical, as exemplified in the electric dynamo and motor, can be faithfully copied by a special form of gyroscope. The author would be interested to know whether the electric dynamo and motor have previously been examined in this particular light, namely, as a form of "electric gyroscope." Fig. 4 shows that the more general case is merely a logical development of the transformer analogy of Figs. 2 and 3, in which the Primary and Planet shafts are made to revolve as a unit in a plane at right angles to the plane of revolution of the Secondary shaft. Three cases are illustrated in Figs. 4 (*a*), (*b*), and (*c*) respectively, together with their electrical equivalents. If I be the moment of inertia of the Planet fly-wheel round its own axis, and $N\,\Omega$ and $n\,\omega$ be the speeds of the Primary and Secondary shafts respectively—the gear ratios shown in Fig. 3 (*c*) are omitted to avoid complication—then the gyroscopic force in the maximum position shown in Fig. 4 (*c*) :—

$$\propto I.\,N\,\Omega.\,n\,\omega \quad . \quad . \quad . \quad . \quad (1)$$

The corresponding magnetic force μ H M

$$\propto \frac{1}{R}.\,N\,C.\,n\,c \quad . \quad . \quad . \quad . \quad (2)$$

where H and R are the strength and reluctance of the field magnetic circuit, M the magnetic moment of the armature, and C and c the field and armature currents respectively. R is, of course, equal to $l/\mu\,a$, where μ is the permeability, a the armature (and magnet pole) area, and l the length of the complete magnetic path. Equating (1) and (2) we see that :

$$R \propto \frac{1}{I} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

as already stated in the case of the telephone receiver. Also the total field flux

$$Z = \frac{N\,C}{R} \propto N\,\Omega\,I \quad . \quad . \quad . \quad . \quad (4)$$

That is, magnetic flux is proportional to moment of momentum in the mechanical model, as stated in tabluated list of analogies.
From (3)

$$I \propto \frac{\mu\,a}{l} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5$$

or $k^2\,m \propto \frac{\mu\,a}{l}$, where k is the radius of gyration, and m the fly-wheel mass, of the Planet shaft.
Assuming that $m \propto a$, the armature area, as in the simpler case of the telephone receiver—see above—then $\mu/l \propto k^2$; that is, the radius of gyration corresponds to the factor of "unit permeability" which determines B, the magnetic flux per unit area resulting from any given magnetomotive force—*i.e.*, the moment of momentum per unit mass due to the geared speed of the fly-wheel shaft. It will be seen that wheel-slip corresponding to magnetic saturation produces the same effect as a decrease in the radius of gyration, *i.e.*, in the magnetic permeability μ.

If the armature be held stationary in the position of Fig. 4 (*c*), it will be seen that the fly-wheel possesses two active moments of inertia, namely I round the Planet shaft, and a second which we may call i round one of its diameters. Thus, gyroscopic action and centrifugal force both share the ability to alter the value of the active moment of inertia of a mechanical model, in a manner which shows that they are true analogies of magnetic attraction and torque respectively. The new moment of inertia i need not necessarily be the same as I, either in the mechanical or electrical machines, as it represents the reluctance of a magnetic circuit at right angles to the main field circuit. Turning to Fig. 4 (*b*), which represents an intermediate position between (*a*) and (*c*), the self and mutual inductances of the armature circuit can be shown by the reasoning employed in an earlier paragraph to be $n^2\,(I\cos^2\theta + i\sin^2\theta)$, and $N\,n\,I\cos\theta$ respectively, where θ is the angle turned through from position (*a*). The corresponding values for the field circuit are $N^2\,I$ and $N\,n\,I\cos\theta$. The degree of coupling between the two circuits is therefore :

$$D = \sqrt{\frac{I\cos^2\theta}{I\cos^2\theta + i\sin^2\theta}},$$

which varies between 0 and 100 per cent.

Thus, we may regard the electric dynamo as an apparatus for the rythmical variation of the degree of coupling between two circuits.

As a final word on the quantitative aspect of the gyroscopic analogy, it may be noted that if the total field flux, which, from equation (4) $\propto N\,\Omega\,I$, is large compared with the armature flux, $n\,\omega\,I$—that is, if field speed is so much greater than armature speed that the reversal of the latter does not appreciably alter the fly-wheel speed—then the gyroscopic torque at any position such as that of Fig. 4 (*b*), is closely proportional to $\mu\,H\,M\sin\theta$, as in the case of a magnet rotating in the earth's magnetic field. It is obvious from the nature of gyroscopic action, that the model shown in Fig. 4, with the addition of some form of reverse gear, will serve to illustrate equally well the action of the electric dynamo and motor. In the latter case, for example, the applied armature current which would cause a clockwise rotation of the armature will be in the opposite sense to that which would be induced by rotating the armature in the same direction, by means of an outside drive. Any attempt to follow the analogy into the details of A.C. and D.C. dynamo and motor characteristics, would be outside the scope of this introductory article, and will therefore not be undertaken here.

Fig. 5 represents an attempt to design a model capable of demonstrating the various principles just explained. The author does not claim that it is a genuine working model, though it might perhaps be possible to convert it into one with the aid of magnetic and motor drives—is it fair to use electricity for such a purpose?—together with some form of automatic reverse gear. It could, however, serve as a demonstration model, to exhibit in slow motion the nature and interaction of the three different motions of the electric machine. The very intricacy of these motions will serve to illustrate the fact, not always appreciated by students, that the electric motor is in reality a complicated machine. The fact that the motions in two of the principal planes, being electric, are not obvious to the eye, tends to obscure their three-dimensional nature, and leads to a false appearance of simplicity.

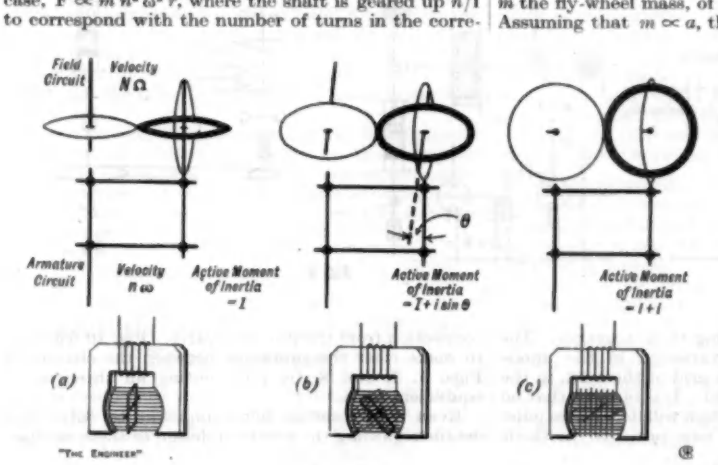


FIG. 4

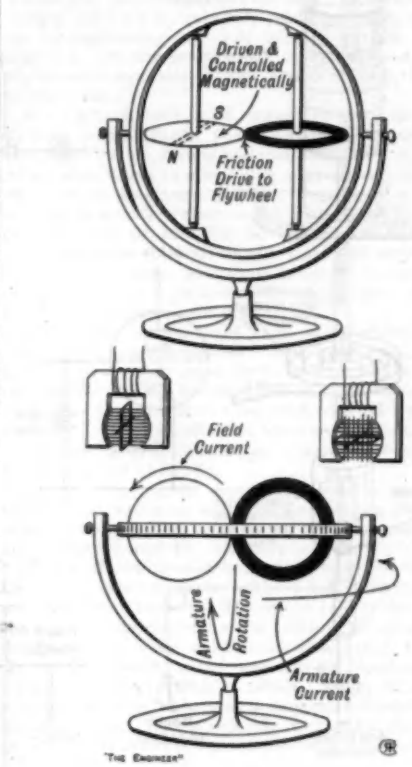


FIG. 5

Low-frequency Wireless Circuits.

Hitherto we have been dealing with electrical machines in which the electrical and mechanical speeds only vary within narrow limits from the average for which they are designed, and this feature is reflected in the corresponding mechanical models. In low-frequency wireless circuits, however, we have to deal with a very wide variation of speed fluctuations, ranging from those of the order already encountered to speeds at the higher end of the audio-frequency scale ; that is, from about 50 to 10,000 cycles per second. This fact dominates all low-frequency wireless design, and the various components have eventually emerged from the experimental stage in the form of skilful compromises between the demands of the top and bottom ranges of audio-frequency impulses. It is not to be expected, therefore, that much success will attend hasty efforts to devise mechanical models to satisfy such stringent conditions Nevertheless, those described below may be found to possess the germs of successful analogies, or at least of useful demonstration models. No attempt will be made to deal with high-frequency impulses ; they may be compared to vibrational effects in mechanical engineering, which tend in practice to over-ride the ordinary mechanical links such as those we are considering now. Many successful analogies for these have already been described in THE ENGINEER. Thus, in spite of the fact that it is theoretically possible to extend the mechanical links already described to high-frequency circuits,

particularly in border-line cases, such as the detector valve and the couplings on either side of it, the author has regarded such applications as being outside the scope of the present article, which he has endeavoured to confine to models of a more or less practical nature.

Fig. 6 illustrates the working of a simple L.F. valve. This is an electrical instrument by means of which small voltage changes in an input or grid circuit produce relatively large changes in the resistance of a separate output or plate circuit. The voltages which operate the circuits are supplied from an independent source. The most important qualities of a valve are its mutual conductance g, voltage amplification factor m, and anode impedance i. These are represented on the model by the pitch of the screw, increase of vane surface per revolution, and viscosity torque for any given setting, respectively. The method of working will be fairly clear from the diagram. The speed of the "anode" shaft under the influence of the impressed torque, varies according to the degree of immersion of the vane in the liquid. The level of the latter is controlled by the vertical movement of the piston, under the influence of the varying torque applied to the "grid" shaft. The liquid clutch in the latter shaft comes into operation—by slipping of the ratchet—whenever the torque acts in a clockwise —positive—direction. In order to prevent this clockwise rotation from taking place a constant anti-clockwise—negative—torque is applied to the shaft, thus holding the ratchet up to its work as long as it is not neutralised by a stronger torque in the opposite direction. The spiral spring represents the grid-filament capacity, which allows a vertical displacement strictly proportional to the net applied voltage. To complete the analogy, it must be assumed that the liquid is too viscous when cold to permit rotation of the anode shaft under the H.T. torque applied. Heating by means of a "filament" coil, however, proportionately reduces the anode resistance. The greater the heat—within the limits of operation—the bigger the anode current for any given grid voltage, and therefore the greater the variation in this current with change of grid voltage; that is, the greater the amplification effect. The vane can be curved to correspond to the "anode bend" in the valve characteristic, as shown in the diagram, and its shape will then be virtually the same as that of the characteristic curve. Reverting to the quantities g, m, and i, it is evident that if g—pitch of screw—is constant, i—viscosity torque at any given setting—will increase with m—increase of vane surface per revolution of

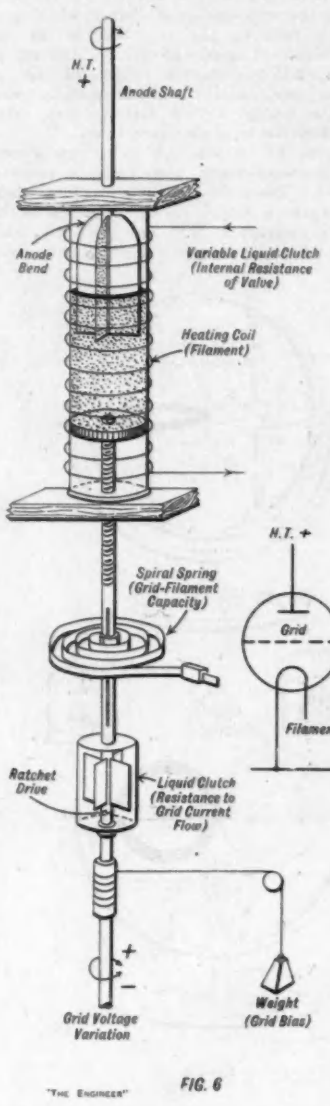


FIG. 6

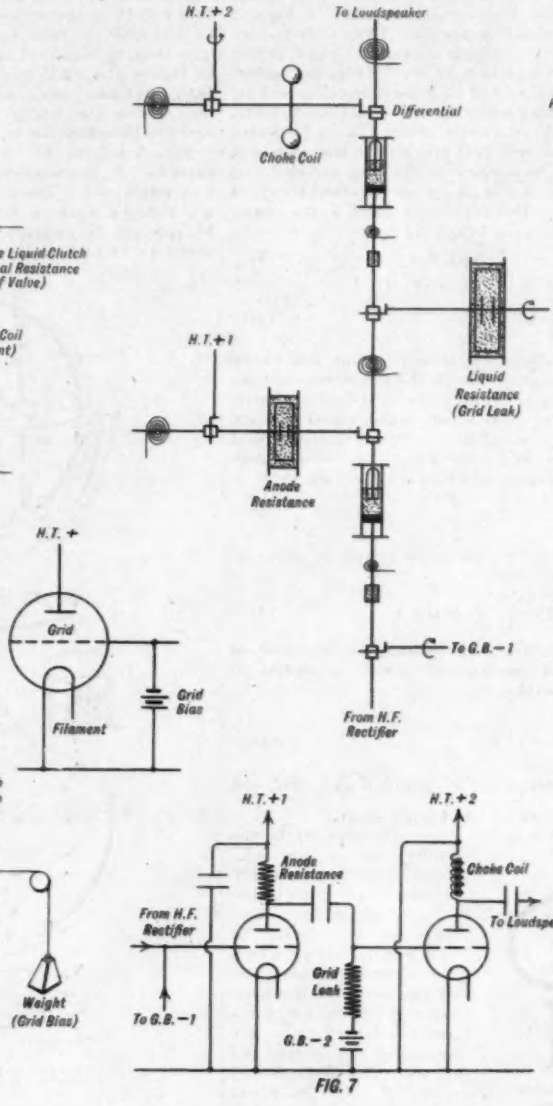


FIG. 7

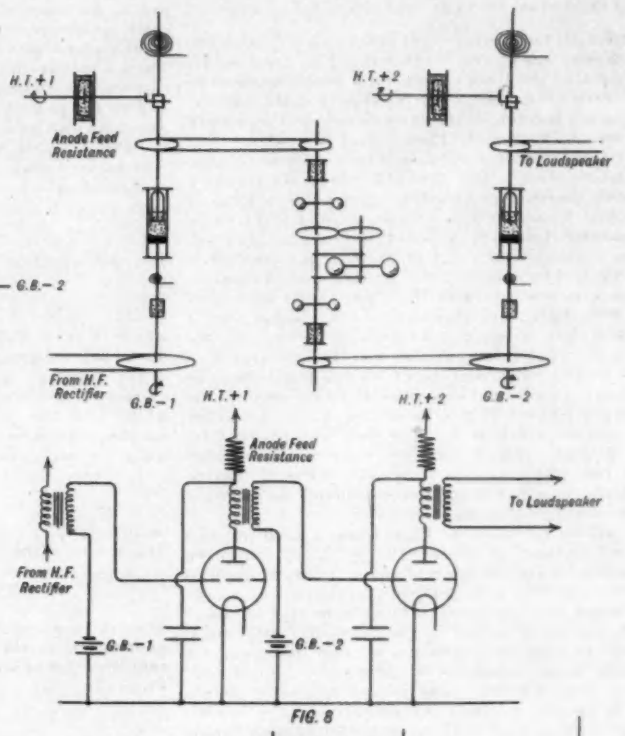


FIG. 8

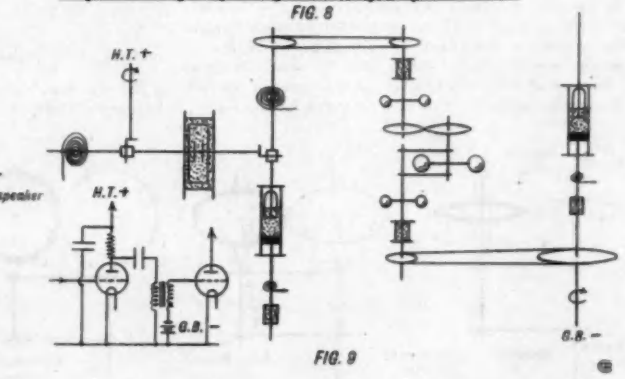


FIG. 9

methods employed for coupling them together. The problem is to transmit a variation in the anode resistance of one valve to the grid of the next, in the form of a variation in potential. It is obvious that no form of direct metallic connection will do, and we must therefore fall back on the two principal methods known at present for the transmission of electrical effects through the ether from one circuit to another, namely, electrostatic and electromagnetic couplings. Both types of couplings—shown in Figs. 7 and 8 respectively—may be regarded as a development of the elementary circuit of Fig. 1, whereby a steady current is broken up into a fluctuating form for a portion of its travel, with the least possible interruption to the source of steady potential. The coupling thus divides naturally into three parts, namely, the anode feed, anode, and grid circuits. The first two are in metallic connection, while the second two are coupled through the ether. In both couplings the valve acts as a form of "make-and-break," but instead of being operated by the current it interrupts, it is acted upon by a "relay" form of connection from the previous valve. Fig. 10 will help to make clear the similarity between the circuits of Figs. 1, 7, and 8, by representing all three in an equivalent form.

Even if the author felt competent to enter into details regarding the practical design of these oscillating circuits, they must be regarded as outside the scope of the present article. He will confine himself, therefore, to drawing attention to a few outstanding points in connection with their nature and development. It will be remembered that these couplings are expected to reproduce faithfully oscillations varying between 50 and 10,000 cycles per second. This is an exacting demand, as every mechanical engineer

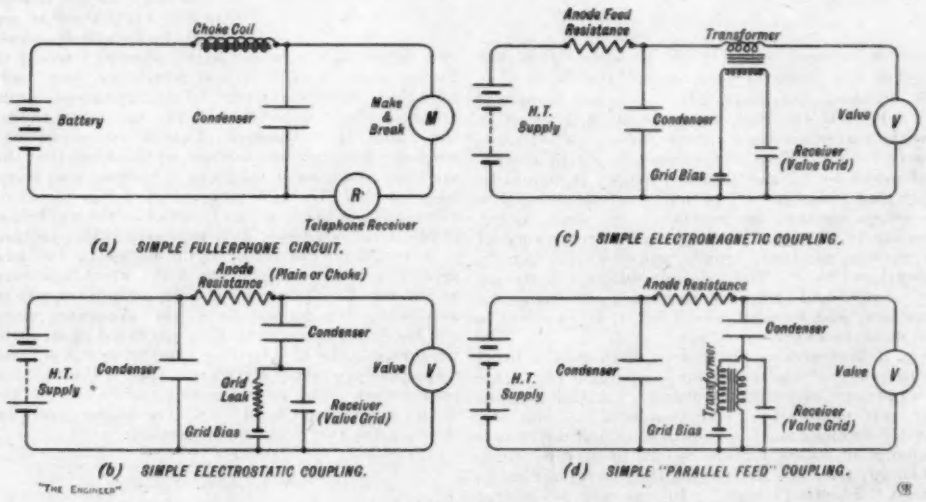


FIG. 10

will agree, and in the early days of wireless, designers found it difficult to adapt the transformer so as to produce a big inertia effect at low frequencies, without its "self capacity" introducing distortion at the higher audio-frequencies, due to resonance successively with the mutual inductance, and the uncoupled primary and secondary inductances, all of which increase in proportion to the frequency of oscillation. This effect corresponds with the tendency in the mechanical model for the various shafts to give at high oscillating speeds, if too lightly made. But in proportion as we add material to them we reduce the transformation efficiency, and at the same time increase their choking effect on both primary and secondary high audio-frequency oscillations. The wireless transformer finally emerges as a skilful compromise between a number of conflicting requirements.

Prior to the development of the modern wireless transformer the resistance-capacity form of coupling, shown in Fig. 8, was the general favourite. Here the difficulties caused by resonance between inductance and self-capacity are overcome by eliminating both these factors as far as possible, and relying only upon the damping effect of a plain resistance. The magnitude of the latter can then be fixed in relation to the rest of the coupling circuit, so as to provide undistorted reproduction over the whole audio-frequency range. In practice it is not easy to produce a resistance which is free both from inductive and capacity effects. The difficulty—expressed in mechanical terms—arises from the fact that the stuff of which the resistance is made can never be divorced from its own inertia and resilience; by careful design, however, both can be reduced to negligible proportions. In the output circuit, where there is no risk of further amplification of any small distortion produced, and fairly large impulses have to be dealt with, the use of a choking coil in place of a non-inductive resistance has always been common practice. The tendency now, however, is to use an output transformer instead, in order to facilitate balancing of the loud-speaker circuit.

An important disadvantage of the transformer coupling illustrated in Fig. 8 is that a heavy oscillating anode current—due to a loud signal—when acting in the same direction as the steady current flowing in the primary, is liable to cause partial saturation of the iron core—corresponding to slip of the Sun Planet gear, as already explained—resulting in noticeable distortion. This can be avoided by adopting the later form of "parallel feed" circuit, as shown in Figs. 9 and 10. This is merely a combination of the couplings shown in Figs. 7 and 8, whereby the advantages of both are superimposed on each other. Thus the inductive effect of the steady current can be excluded by the condenser coupling, whilst at the same time the step-up effect of the transformer link is retained.

In conclusion, the author would like to emphasise once more the tentative nature of the foregoing attempt to correlate a few of the electrical and mechanical activities of that common matter-cum-energy with which we are all so intimately concerned in this scientific age.

Materials for Service at High Temperatures.

AT a meeting of the North-Western Branch of the Institution of Mechanical Engineers, held at the Engineers' Club, Albert-square, Manchester, on Thursday, February 18th, with Professor Dempster Smith in the chair, Mr. R. W. Bailey presented the paper on "Testing of Materials for Service in High Temperature Steam Plant," written jointly by himself and Mr. A. M. Roberts, B.Sc., A.M.I. Mech. E., which was referred to in our issue of February 26th.

Dr. N. P. Inglis, of Billingham, opening the discussion, said he feared that the application of what he would like to call the spheroidisation equation might become a little complicated in practice, chiefly because of the unknown degrees of cold working. The very important question of embrittlement had been very rightly stressed by the authors. A great deal of work had been done in Billingham during the past three years on that matter, and investigators were interested in the 400 and 600 range of temperature. Tests carried out in a very similar manner to those of Mr. Bailey's gave results in close agreement with Mr. Bailey's. The specimens were subjected to a definite stress and definite temperature for eight hours, and the cycle was then repeated 50 or 100 times. He quite agreed that the fluctuations of stress and temperature might not be necessary to the test, but they represented service conditions, and were valuable on that account. In the case of mild steel, the worst temperature for embrittlement was 250 deg. It was rather interesting to note, he said, that for the 450 deg. Cent. steam and 800 lb. pressure installation in the power station at Billingham, the bolts were of nickel-chrome-molybdenum of the type which did not become embrittled. The station had been working for two or three years, and recently some of the bolts had been taken out and when tested showed that the impact value after that period had been entirely unimpaired. The authors had pointed out—and he would like to confirm it—that steels which had become embrittled in that manner showed no change in microstructure, nor was there any change in tensile properties. There, again, Dr. Inglis said, they at Billingham had done even more experiments to determine what other effects that embrittlement process had. They had carried out fatigue tests on embrittled material, and had found that the fatigue curve was exactly the same as for the ordinary material. Then they had done some further tests with a very sharp notch cut in the fatigue specimen, and again the embrittled material had been the same. There must be, said Dr. Inglis, many power stations which had used nickel-chrome bolts, and those would give impact values of 3 or 4 foot-pounds. In view of the other tests coming out so satisfactorily, it seemed rather doubtful whether new bolts should be fitted. If they had a new bolt which gave, say, 5 foot-pounds impact value, it would be rejected. They had there, however, a material which was absolutely sound in every respect, and a very interesting debate could be conducted on whether such bolts could be kept in service or not. Mr. Bailey had indicated a trend, which was very pronounced in all papers which had recently appeared dealing with the effect of molybdenum in steels, and it was quite clear that molybdenum had a very profound effect in modifying the creep characteristics. It was important to know that those creep characteristics did not increase progressively as the molybdenum increased. There was a perfectly definite molybdenum content, which, added to each composition, gave the increase in creep characteristics.

Mr. Winterbottom, referring to spheroidisation, said that from theoretical considerations the slope of the log of the oxygen constant and the reciprocal of the absolute temperature would be a straight line.

Mr. Moneypenny said, in regard to embrittlement, that the amount did not apparently depend entirely on the analysis of the steel, so far as shown by the ordinary chemical tests. It did not always follow that steels of a certain type in the same experiment were free from that embrittlement. What was a suitable period for a test for embrittlement? Mr. Bailey and Mr. Roberts had suggested from about 100 to 200 hours. He thought that time was rather short. Why did Mr. Bailey suggest the very rapid creep rate of 10^{-6} per hour? That creep rate was so rapid that it meant that the useful life of any body would be considerably less than six months; 10^{-6} per hour meant very nearly 9 per cent. extension in twelve months, and with most steels it was not safe to go beyond 5 per cent. total extension. One might suggest that the value put as a creep rate even for 10^{-5} per hour might perhaps mislead some engineers, who were not used to creep rates, into thinking that those particular values were really creep values; 10^{-6} per hour generally meant that the stress had to be reduced at least one-half. Any values of 10^{-5} per hour were of no use for design purposes.

Mr. H. L. Guy said that the high points in the authors' thesis appeared to be as follows:—

(*a*) Temperature determined the rate at which changes took place rather than the character of the change. Carbide spheroidisation provided a characteristic example which the authors appeared to regard as typical.

(*b*) That the creep rate of a material with the carbide completely spheroidised showed that the creep was very much greater than that of the material with the cementite in the lamellar condition. In the case cited for ½ per cent. molybdenum it was 240 times as great, whereas in the case for 0·15 and 0·4 carbon steel at 500 deg. Cent. it was about ten to twelve times as great.

(*c*) Stresses of the order met with in service had no influence on the time for spheroidisation at a specific temperature.

(*d*) The authors considered that the influence of working conditions of stress and temperature in changing the structure of carbon steel could be reproduced by heating the material at a high temperature for a period of time determined by a law.

If the law connecting temperature and time held, the effect of temperature on the rate at which changes took place was brought out in the figures shown, but the results were more significant if the times were stated in terms of years, when they became as under:

Temp. °F. ..	750	..	850	..	950	..	1000
Years	2290	..	57	..	2·17	..	0·51

The fact that a change would take place in two years at 950 deg. which would take 2000 years at 750 deg. Fah. explained why, when the authors' views were first published, constructors of power plant had found it difficult to believe that some of the phenomena could take place in such a marked way as the authors suggested.

Referring to the influence of carbide spheroidisation at temperatures occurring in steam plant, Mr. Guy said that if the proportions of a machine part were determined wholly by creep considerations, its area with the carbide completely spheroidised would need to be two-third greater than that with the cementite and lamellar condition.

The authors' contention that materials should be tested by making Izod tests after they had been subjected for 100 and 200 hours to a temperature of 450 deg. was a thoroughly practical suggestion which deserved incorporation in standard specification for materials to operate at high temperatures. The authors, he thought, were liable to under-assess the influence of embrittlement. Since in most plant, vibration was present to some degree, and the parts subject to considerable change of stress, owing to temperature differences as the plant was started up and shut down, it was probable, and experience unfortunately had supported the view, that fractures from that rapid decrease of Izod values with time might occur during operation; in fact, the phenomenon was so important that the authors were amply justified in putting forward their view that creep tests must be accompanied by embrittlement tests, if they were to be of any value in discriminating between different materials.

Another of the important matters brought forward by the authors was that it was not sufficient to record a minimum creep rate, but that engineers required for many purposes a total creep rate, and their proposal that results should be given both for minimum and for definite total extensions must be adopted if the information required by designers was to be obtained. In one class of structural designs, such as a bolt, it was probable that the minimum creep rate alone would give the information necessary to determine its design, since the initial creep could probably be taken up by tightening the bolt after a certain definite interval. On the other hand, it was the total creep which was important in the design of such things as turbine discs.

Mr. Colbeck said, with regard to the question of modern steam plants, that there were a number of factors which Mr. Bailey had just mentioned in passing which were likely to affect very considerably the creep data which had been given. There was a certain amount of evidence that, under high pressures and at temperatures of 450 deg. to 500 deg. Cent. a considerable scale formed on the inside of superheater tubes. That scale contained a large percentage of peroxide of iron. It seemed possible that hydrogen attack might come into play there.

Mr. L. E. Benson said that, although the term "complete spheroidisation" had been used, it was perhaps not a very good term, and he was sure that neither Mr. Bailey nor Mr. Roberts nor any of their assistants thought that they had reached a state of stability. If only sufficient time were given, he did not see why they should not get a lamellar of cementite and a lamellar of ferrite.

Dr. H. Carrington described some results of a torsion test which he had made about ten years ago at room temperature on a bar of ordinary mild steel, ⅞in. diameter and 4in. effective length.

Mr. D. M. Smith said he noticed that the whole of the creep tests which the authors had described were tests in direct tension. He would like to emphasise the urgent importance for the solution of problems in design which were continually occurring in tests carried out with other systems of loading, and especially in tests with bending. When creep took place in bending, there was a very considerable stress redistribution. Was it possible to transfer the results given by the authors for tensile tests to bending?

Fatigue of Mild Steel.

IN November, 1930, the Council of the North-East Coast Institution of Engineers and Shipbuilders appointed a Committee under the chairmanship of Sir Westcott Abell to consider the preparation of a definition of Fatigue. The Committee reported to the Council in October last, and a few days ago the Council announced that it had adopted the Report and issued it. With the permission of the Institution we reprint it below and express the hope that it will be widely discussed.

THE NATURE OF THE PROBLEM.

(1) The object of the Committee is to inquire into the meaning of the term "Fatigue" as applied to mild steels—0·10 to 0·35 per cent. carbon—and commonly used both in the rolled, cast, and forged states for engineering work.

THE FORMER MEANING OF FATIGUE.

(2) In his work on "Applied Mechanics," and in the fourth edition of 1895, J. H. Cotterill says that "Where a load within the elastic limit produces no permanent change, it follows that the load may be repeated indefinitely. Experience confirms this conclusion, for the balance spring of a watch bends and unbends a million times a week for years together, and the parts of a machine, if sufficiently strong, remain so to all appearance for an indefinite time. But if the load be beyond the elastic limit, permanent changes are produced and there is every reason to believe that a slow deterioration of strength is ultimately destructive."

James Thomson, in 1848, suggested that while the initial limits of elasticity might be low, due to the conditions produced by manufacture, yet, by applying a heavy load which would by plastic flow relieve these stresses, the subsequent applications of smaller loads would not cause any further change of form. He put forward an important theorem stating, among other things:

(1) That there are two elastic limits for any material between which changes of form must be confined if we wish to avoid permanent set or a succession of permanent sets.

(2) That these limits may be called the superior and inferior limit of the change of form *for the particular material and for the particular arrangement of its particles.*

From which it is clear that Thomson inferred that

between certain superior and inferior stresses the material would retain its elasticity and that these stresses and their range would depend not only on the particular material, but also on the nature of its internal structure. He foresaw the effect of retaining the same chemical composition while altering the physical structure by heat or other treatment.

In 1860–61 Sir William Fairbairn made his famous experiments for the Board of Trade on a built-up girder of wrought iron having an estimated breaking strength of 12 tons. Experiments showed that this girder could stand over three million repetitions of a stress of 5·71 tons per square inch tension, but that greater loads caused fracture at a smaller number of applications. From these experiments came the idea that there was a limiting load which could be applied for a very large number of times without causing failure.

The experiments of Wohler, published in 1870, threw much wanted light on the effect of repetitions of stress. Much of Wohler's work was made on a rotating bar loaded at one end—so that in one revolution the bar experienced both tension and compression. In other experiments, bars were loaded in various ways and the load wholly or partially removed at intervals. The process was repeated until the bar broke and the number of repetitions was shown to depend not only on the maximum value of the stress, but also on the range of stress. For example, with a bar of axle iron made by the Phœnix Company in 1857, it was found that for a range of stress between $\pm 7{\cdot}6$ tons per square inch, i.e., between 7·6 tons tension and 7·6 tons compression, the bar was unbroken after 132,000,000 repetitions, whereas at $\pm 8{\cdot}6$ just over 18 million reversals broke the piece, and at $\pm 15{\cdot}2$ tons it could only withstand about 56,000 alternations.

These experiments, which gave support to James Thomson's theory, were confirmed by the work of Bauschinger from 1881 onwards.

Sir Benjamin Baker made in 1886 a number of experiments on the steel to be used for the Forth Bridge, and found that the cause of failure under repeated stresses is often due "*not so much to a gradual deterioration or crystallisation of the metal as the establishment of small but growing flaws.*"

Cotterill, already quoted, commenting in 1895 on these experiments, says that the gradual deterioration of strength is, so far as is known, confined to the section where fracture occurs. "The character of the fracture indicates that minute cracks are produced which gradually become large flaws as the repetition continues. These facts show that it is not absolutely necessary to suppose an actual diminution of the strength of the material itself, such as is *commonly described by the term fatigue.* The crack may conceivably be initially produced by vibrations in the elastic solid of the nature of those producing sound for such vibrations though representing a small amount of energy, *are capable of considerably augmenting the stress due to an external load.*"

(3) It appears to be clear that at the time Cotterill wrote—in 1895, or before—that the prevalent idea of the term fatigue was an actual diminution or deterioration of the strength of the material itself after repeated stresses. It is not clear, however, that distinction was made between stresses within the elastic limit and those beyond that limit. There also appears from the statement of Baker to have been some idea of the metal altering its crystalline form under repeated strain. Cotterill, however, appears to have been doubtful of an actual change in the nature of the material, and, arguing from the fact that the deterioration of strength appears to be confined to the section where fracture takes place, seems to have had an idea that there may be some phenomenon present which considerably increases the stress due to the external load.

H. J. Gough, in his work on the "Fatigue of Metals," published in 1924, page 157, says: "From the earliest days of mechanical testing a belief seemed to exist—and, in many quarters, still exists—that fracture due to repeated stressing was fundamentally different from that due to statical stressing. In the discussion of fractures due to repeated stresses, remarks have been made such as 'evidently crystallised through fatigue' and 'there is now ample evidence that fatigue has caused them to become crystalline and therefore brittle.'"

(4) It must be remembered that in those early times the study of the structure of metals with the microscope was in its infancy, although Sorby first used this instrument in 1864 for such purposes. It is now possible to examine the internal crystal structure, not only by the microscope, but by the use of X-rays.

Long before there was any knowledge of the internal structure of metals, it was known that failures might occur at less severe stresses than the material would stand under static tension, if these lower stresses were repeated a sufficient number of times.

The implied meaning of the term "fatigue" was thus the failure of a metal under repeated stresses in some mysterious and unknown manner. The general impression was that "fatigue" followed an actual diminution of the strength of the material itself, perhaps taking the form of some change in crystallisation. Cotterill, however, had an idea that in such failures peculiar circumstances might arise which would have the effect of causing an increase of stress locally.

Modern Research Regarding Causes of Failure under Repeated Stresses.

(5) Consideration of the work undertaken in the present century may conveniently be dealt with in the form of four distinct problems:

(*a*) The effect of repeated stresses on the crystalline structure at ordinary temperatures.

(*b*) The effect of small cracks or flaws on the distribution of stress.

(*c*) The characteristics of fracture under repeated stress, and

(*d*) The relation of the limiting stresses under repeated applications to the mechanical properties determined by other tests.

The Effect of Repeated Stresses on the Crystalline Structure.

(6) Ewing and Rosenhain, from microscopic examination, showed in 1900 that permanent deformation under static loading does not change the crystalline structure, the visible deformation being brought about by a process of "slipping" within the crystals.

Gough, on page 158 of his book, shows that the crystalline nature of a fracture of Armco iron is not altered after repeated stresses, although the crystal itself has broken down. He then refers to the more precise method of X-ray analysis, by which means the atomic distribution of a single metallic crystal can be determined with precision before and after straining.

He says that using such methods, it is now definitely known that the crystalline nature of a metal is not altered by the application of statical or repeated stresses. Hence, the conception that the effect of "fatigue" upon a metal is to change its structure from non-crystalline to crystalline may be at once dismissed as being totally contrary to fact.

Gough, also, on page 187, dealing with various theories of fatigue failure, says: "That failure under repeated stresses was due to the crystallisation of the metal, was conclusively disproved by the work of the physical metallurgists, and later by the X-ray analysis of metals."

There is, therefore, sufficient evidence to show that *at ordinary temperatures the breakdown of metals under repeated stresses is not due to any change in the crystalline structure of the metal.*

(7) It may, therefore, be concluded that the deformation of a metal under stress is confined to the crystals themselves, and that within certain limits of stress the crystals may submit to elastic deformation, and may in fact supply what may be termed the elasticity of the metal. It also follows that a crystal may undergo some permanent deformation without actually "splitting," and still retain some elastic properties.

(8) It is important to consider whether fracture occurs *through the crystals* or *along the crystal boundaries.*

Gough, on page 159, comparing tensile fractures, says that microscopic examination shows that the breakdowns occurred *through the crystals*, and *not along the crystal boundaries.* And, later, pages 160, &c., when dealing with repeated stresses, says that the path of the fracture lies *through the crystals.*

Rosenhain (*Dictionary of Applied Physics*, 1923, Vol. V., page 406) says: "One would, perhaps, expect that the path of fracture would ordinarily follow the crystalline boundaries. This, however, is conspicuously not the case."

It appears therefore that in both classes of overstress, failure first takes place *within the crystals themselves.*

The Effect of Small Flaws on Stress Distribution.

(9) The second important question which needs consideration is that first suggested by Cotterill, whether, in repetition fractures, there are any circumstances present which may give rise to a considerable increase of the stress caused by an external load.

It is well known in engineering work that the presence of comparatively small discontinuities may give rise to large increase in the stress, and that such increases extend for only a small distance from the discontinuity. This increase in stress is well known to shipbuilders and to engineers, and by experience they have learnt to provide remedies, which have for their object the equalisation of stress in the neighbourhood of the discontinuity in section.

It may, therefore, happen that the limits of repeated stress may be affected appreciably by the nature of the surface of the test piece, the extremely small discontinuities being sufficient to cause a local increase in stress which may facilitate the breakdown of a crystal in its neighbourhood. Several mathematical solutions have shown that a large increase of stress is possible and in particular Southwell (*R and M** 1003/1926) has calculated that if a small flaw of the shape of a hemisphere be cut in a circular shaft subjected to a shearing stress S, the principal stresses will be increased from $\pm S$ to $\pm 2{\cdot}7\,S$ at the surface of the flaw, and that this increase of stress dies away very rapidly from the flaw. Other calculations have also suggested that the shear stress may be increased as much as three times for a very local region.

(10) W. N. Thomas published in *Engineering* of October, 1923 (*R. and M.** 860/1923), a report on the effect of scratches and various workshop finishes on the repetition stress limits, and his results confirm the view that even discontinuities of so small an amount as he considers, appreciably lower the permissible stresses. The tests were made on 0·33 carbon steel where the limiting stresses were found to be $\pm 18{\cdot}3$ tons per square inch. Two kinds of scratches were made, one by a diamond and the other by a lathe tool, and the Wohler tests were carried to 6×10^6 repetitions. The reductions in stress limits due to the V notches were shown by experiment to be 13½, 23½ and 29 per cent., while Thomas estimated that a coarse file surface would produce 18 to 20 per cent., and a turned surface 12 per cent.

(11) It is proved that a small flaw of measurable extent will cause a considerable rise of stress. It is equally true that some discontinuity of section caused by a keyway or by a sudden change of direction, such, for example, as where a crank shaft web joins the shaft—Stanton and Batson, *I.C. Engine Sub-committee Report No.* 15, 1917—will cause a redistribution of stress which may give rise to a very high local stress, unless special means are taken to minimise the effect of change of shape or direction or of area.

It is thus possible with a circular shaft in which the stresses are kept within permissible limits, to have discontinuities made in it or attached to it, which will cause such a redistribution of stress as to bring about a very local stress exceeding the permissible limits. To this phenomenon has been given in America the name of "stress raiser"—meaning any lack of uniformity which may raise locally the stress, otherwise permissible, distinctly above the limits at which breakdown occurs after a sufficient number of repetitions. Consider a simple example—the circular propeller shaft of a motor car taking the pinion driving the crown wheel of the differential gear. For cheapness of manufacture the main shaft may be turned down where the pinion wheel is to be placed with a sharp neck—giving an example of a stress raiser whose effect may, however, be minimised by rounding off the end of the larger diameter and also rounding a fillet to the smaller diameter. In addition and just beyond the shoulder, a keyway is cut in the smaller diameter which is square-ended and square in section—which introduces a second stress raiser, again causing a redistribution of stress which has already been raised by the first discontinuity. If both these stress raisers are sufficiently near, and if means are not taken to round off properly all corners in every direction, then if the shaft itself is designed for the permissible limits of stress, it is pretty certain that a crack will occur at the keyway owing to the stress exceeding the physical limits which the crystal can withstand. And if, further, as may happen, the engine be tuned up to a higher power than the design allows for, it is pretty certain that fracture will follow and that it will occur at the discontinuities of section.

(12) The question then arises as to the redistribution of stress which will follow a microscopic crack such as occurs when, owing to excessive stress, a crystal breaks down by fractures or slips along the cleavage plane. Here, the crack is narrow in proportion to its length, and from experience with such cracks in shipbuilding, it is fairly clear that the redistribution of stress causes a much higher intensity of stress than in an artificial crack of finite and symmetrical form. From this point of view it is fairly certain that when once an original crack has been formed, the consequent rise of stress is sufficient to cause the crack to grow, even when the material otherwise is subjected to a reasonable working stress.

(13) It is to be remembered, also, that after a minute crack has been formed, it still takes a long time for it to grow through a sufficient amount of the section as to cause fracture. This is in accordance with the knowledge of the behaviour of stress raisers—since, in all the cases which it has been possible to calculate, the high stress surrounding a flaw is very local in occurrence and thus can only fracture the affected crystals at a comparatively low rate. That is, of course, unless the stress, in the absence of a crack, is not itself above the permissible limits.

It would, therefore, appear, when considering both repeated and reversed stresses, that when a microscopic crack has been formed in a crystal, the consequent redistribution of stress is sufficient to cause the crack to extend not only through the crystal, but also to adjacent crystals.

Such a crack will not be originally formed unless the range of repeated stresses exceeds certain definite limits which for material of given chemical composition depends on the arrangement of its particles. This conception of the mechanism of failure accords with the shadowy idea of Cotterill that in such cases there may be present some factors which may bring a considerable augment of the stress due to an external load.

The Characteristics of Fracture under Repeated Stresses.

(14) Modern research on the effects of repeated stresses has made it clear that the process of failure, starting from the first formation of a crack and finishing with a complete fracture, can be divided into at least three distinct stages somewhat as follows:—

(*a*) In the first stage a particular crystal is subjected to repeated stresses which exceed certain permissible limits, with the result that after a certain number of repetitions an actual crack is found in the crystal.

(*b*) In the second stage the alteration in the stress distribution consequent on the formation of a crack, causes the crack to grow slowly, to extend to adjacent crystals, and gradually to form an enlarged surface of separation, which in a circular shaft follows a skew or spiral surface.

(*c*) Lastly, the separation of the two parts has reached a stage where the reduced area and the altered distribution of material is only just sufficient to withstand the normal load. Momentarily, a slight overload occurs and the piece breaks suddenly, the final break showing the characteristics of a rough and angular nature, such as are caused by a shock fracture.

(15) It is necessary to examine any experiments which may afford evidence of this idea. Gough, on page 164 of his book, says that the mechanism of failure in a metal subjected to repeated stresses is entirely different from that due to static tension. He quotes the tensile fracture of mild steel, which, he says, usually reveals a silky fibrous structure owing to the crystals having become drawn out to long threads before breaking in an irregular manner.

He further says that "under repeated stresses a crack is formed in the process of fatigue. *Owing to its shape, concentration of stress occurs at the end of the crack and the crack extends owing to this stress concentration.*" And later on, "*It is well to emphasise that the mechanism of the propagation of a crack is entirely different in character from the action of fatigue which led to the formation of the crack.*" Gough, therefore, clearly distinguishes between the causation of the initial crack and the mechanical consequences that follow when once the crack is formed.

(16) It is about this stage that difficulties begin to appear regarding the meaning of fatigue—for this term appears to be applied both to the circumstances leading up to the formation of the initial crack as well as to the consequences of the formation of such a crack. In this connection, Gough himself says very clearly that "the phenomenon of the behaviour of materials under repeated stresses of high frequency has by common usage become associated with the title of fatigue," and from this statement it follows that the term can be used in more than one sense.

(17) A paper by Southwell and Gough, published in the *Philosophical Magazine*, January, 1926, and *R. and M.*, 1003, contains a theoretical examination by Southwell of the effect of the redistribution of torsional stress caused by a small spherical flaw in the surface of a circular shaft. Southwell predicted that if artificial flaws are made in an otherwise normal material, helicoidal fractures would develop when such material was subjected to reversed torsion.

Gough carried out experiments on these lines on two carbon steels—0·27 per cent. C and 0·65 per cent. C.—using hollow specimens and drilling a small hole $\frac{1}{32}$in. diameter radially through one side. The paper says that "*in all cases*, when a flaw was created by drilling and the specimen then subjected to alternating torsion, helicoidal fractures resulted," and Gough says in his book, page 172, "the experiment confirms Southwell's theory: the importance of the theory is very great, as it affords a key to a

* Reports and Memoranda of the Aeronautical Research Committee.

very puzzling aspect of fatigue phenomena, the spiral fracture in particular and the nature of 'cracking' under repeated stresses in general."

If anything is clear at all, it is that when once a fracture has been produced, the subsequent stages in the failure of a circular shaft subjected to torsion arise from a redistribution of stress. In fact, if there were sufficient knowledge, it would be possible to ascertain from the shape of the fracture, the actual distribution of stress over the section during the various phases.

The Relation between Limited Stresses for Repeated Applications and other Mechanical Tests.

(18) Any review of the question of fatigue would be incomplete without some discussion of the manner in which elasticity of the material is provided. There is little doubt from modern research that deformation of the crystal itself provides the elasticity and that this property is not dependent on the connection between the crystals, i.e., on the cement, cohesion, force or attraction which may exist at the crystal boundaries. This is true as long as the material retains elasticity—that is, so long as the applied stresses are not so high as to cause a permanent deformation.

(19) Any user of material should know the physical limits of stress which it is able to withstand without permanent breakdown, and in particular to have a measure of these limits for different directions of stress, whether tension, compression, bending, or torsion, determined either statically or by repeating, for a large number of times, certain ranges of stress between zero and a maximum, or between positive and negative values.

Generally, however, acceptance tests for material depend on the properties of the material beyond the elastic limits, such as ultimate tensile strength elongation and contraction after rupture, which properties have little, if any, relation to the work which the material has to withstand in actual service. There has lately, however, been introduced a test of the limit of proportionality for structural material.

(20) On the other hand, the work of many experimenters on the properties of ferrous metals has provided a large number of measures of elasticity which should give some indication of the stresses to be allowed for in any ordinary mild steels, whatever the direction of the stress.

In addition to tensile, bending, and torsion tests, both static and repeated, impact and hardness tests are also made. These tests do not seem to bear directly on elastic properties, but, like the ultimate tensile stress and the elongation, are rather physical tests of the structure of material than measures of elasticity.

(21) To obtain a knowledge of the elastic properties of a material which can be produced of uniform character, both as regards its chemical and physical natures, it would be necessary to know the limiting stresses for :

(*a*) Statical tension and, perhaps, compression.
(*b*) Repetitions of reversed bending.
(*c*) ,, ,, ,, torsion, and
(*d*) ,, ,, ,, direct stresses.

It would be advantageous if it were possible to obtain one of these series and to determine that for any other, by a coefficient depending on the nature of the material.

It is to be anticipated that such a relation exists, if, as is believed to be the case, the elasticity depends on the crystal itself. For with a given nature of crystal, there will be a consequent arrangement of particles and there should be some relation between the work required to distort elastically in different ways. If, therefore, the metallurgist can produce a material of uniform nature, both chemical and physical, and mild steel is produced easily with great reliability and in large quantities, the relation between the various elastic measures should be capable of being found.

(22) Gough has devoted much attention to this part of the problem and says (*R. and M.*, 1012) that with proper precautions, a metal of normal homogeneity, tested in a *particular type* of machine, will usually give repeat test results of such a consistency, that it can be concluded that the limiting range of stress is a real physical property of the material.

It is clear, then, that the results obtained should vary with the manner of application of the stress which can be divided into :

(*a*) The pattern and finish of the test specimen (*R. and M.*, 1012).
(*b*) The way in which the load is applied by the machine and possibly by the speed of repetition of stress (*R. and M.*, 1012 and 982),

which resolve into two simpler conditions,

(*c*) The stress distribution over the test specimen, and
(*d*) The stress application peculiar to the machine.

Comparison between the various elasticities can only be obtained if the test piece is so made that it can evenly distribute the stress of a particular kind and if the machine can evenly load the test piece with the particular kind of stress, and that stress only.

Now, there are distinct variations betwen testing machines themselves, and, consequently, the application of stresses will vary with the type of machine employed. All that can be said is that a load applied to a particular form of test piece for a number of times in a certain type of machine will give the limits of stress for a given homogeneous material, the distribution of the stress depending on the type of machine used.

(23) The correlation of the tests is certainly a difficult problem, a very necessary one, and one which so far has not given any consistent results.

Gough, in his book, has given much consideration to this question, and reaches the following conclusions for ferrous metals :—

(*a*) For a wide range of ferrous metals, varying from a tensile limit of proportionality from under 10 tons per square inch to over 80, there is no general relation of the proportional limit to the repeated reverse bending stress limit.

(*b*) A comparison shows the total lack of any relation between the single blow impact tests on notched bar and the repeated reversed stress limits.

(*c*) From a general survey of qualities, a relation appears to exist between the ultimate tensile strength and the limiting stress for repeated revérsed bending, the latter averaging just under 0·5, the former, for ultimate strengths covering 19 to 130 tons per square inch. This ratio may, however, be as high as 0·6 and as low as 0·35.

(24) The results of these examinations appear to show that hitherto a general relation between the various elasticities of ferrous metals has not been found. It is fairly clear that relations should exist, and it would be advantageous to determine them for the simple materials under consideration, namely, mild steel with carbon content up to 0·35. Such material can be made uniformly and reliably, while heat treatments can be given under proper control. If the chemical and physical characters of the material can be specified, and if standard test pieces be subjected to the various stresses in accepted types of testing machines, the relations between the various elasticities ought to be determinable.

The Present Meaning of Fatigue.

(25) It is clear from many aspects that there is at present misunderstanding as to the meaning of the term fatigue. In its use by experimenters it is held to include all failures which may arise from repeated stresses, whether these are due to insufficient material, or whether they are due to improper distribution of sufficient material.

One thing which is evident is that it does not relate to any deterioration or tiredness after repeated stresses, since such phenomena have been shown to be imaginary.

In the introduction to his book on "Fatigue," Gough says : "The phenomena of the behaviour of materials under repeated stresses of high frequency has, by common usage, become associated with the title of 'Fatigue'; the term is far from ideal, being much too indefinite and misleading. One is, however, faced with the fact that the term is widely employed, and to avoid confusion it has been adopted in the present book. As a definition, 'Fatigue of Metals,' therefore, means the behaviour of metals when subjected to repeated stresses."

Under this definition, fatigue is applied to the failures which occur in the crystals themselves and also to those which arise from a faulty distribution of stress. It is also used for cases where, owing to undue loading, an initial crystal failure occurs with consequent local intense stress arising from the redistribution of stress involved by the formation of a crack. It includes within its meaning both the questions of physical qualities and mechanical consequences.

(26) In the light of this present examination, it appears that with a uniform ferrous material, the crystal does not fail unless the stress on it exceeds certain determinable limits. The initial failure occurs because it is over-stressed, and this can be prevented by providing sufficient material and by seeing that the material is so disposed as to reduce the stress to permissible limits. Where this is done, the particular section of material under the given load should be capable of withstanding a very large number of repetitions of stress.

The initial failure may be due to :—

(*a*) Either a defect in a crystal itself, or
(*b*) Too great a stress arising from
(i.) Insufficient material as a whole.
(ii.) Sufficient material as a whole, but improper local distribution.
(iii.) A lack of uniformity in the material at a particular part.

While the crystal defect and the lack of uniformity arise from manufacture, the insufficiency of material, either locally or as a whole, is within the discretion of the designer and is a matter of stress distribution.

The designer can determine by calculation and by experiment the proper distribution of material to prevent the stress exceeding the permissible limits, and when this is done, the manufacturer has to produce the uniform material of specified quality which will give the desired limits of stress.

(27) If, therefore, the term fatigue is to have a distinct meaning, that meaning should necessarily apply to the permissible limits of stress which a material will withstand for a large number of repetitions of stress.

It would help both the designer and the manufacturer if the term were not used for any question of distribution of stress whether this be caused by original insufficiency of material, or whether it arises from an initial crack due to some metallurgical deficiency or inequality.

If, in the case of failure, it can be shown that the material is not uniform in nature, or reliable in character, and does not reach under test in standard machines the specified permissible limits, then the fault is metallurgical. If, on the other hand, the material satisfies all the physical tests, the failure will arise from a faulty stress distribution and experiments should be able to show where the defect occurs.

A Suggested Definition of Fatigue.

(28) It is the considered opinion of the Committee :

(*a*) For the particular material under consideration i.e., mild steel of carbon content, say, 0·15 to 0·35 per cent. of uniform nature and manufacture, there exist at ordinary temperatures certain limiting stresses which it can withstand without failure for an indefinitely large number of repetitions when exposed to (1) reversed bending, (2) to reversed torsion, or (3) to reversed direct tension and compression.

(*b*) The values determined for these limiting stresses vary with the type of testing machine used, and with the shape and surface finish of the specimen tested. Steps should be taken to agree on standard forms of machines and on standard test pieces, so that the relation between the several limiting stresses can be determined as well as the relation of these stresses to other mechanical properties.

(*c*) The term "fatigue" should only be used when, from one of a variety of causes, any of the limiting stresses have been exceeded.

(*d*) With the above sense, the term "fatigue" means that the material has been subjected to long, continued repeated and reversed stresses, which have exceeded the limiting values.

(*e*) That "fatigue," with the sense defined, may arise where the amount and disposition of the available material are such that the stress either wholly or locally exceeds any of the above limits.

(*f*) The term "fatigue failure" should be used to describe any method of failure which follows when any of the above limiting stresses have been exceeded.

SIXTY YEARS AGO.

Our issue of March 8th, 1872, was chiefly notable for the detailed account which it gave of Monsieur Dupuy de Lôme's "aerostat." During the Siege of Paris in 1870 Monsieur de Lôme had laid before the Academy of Sciences his proposals for the construction of an "aerostatic machine" which would be capable of motion in a selected direction relatively to the wind or, in modern phraseology, for the construction of a dirigible balloon. His ideas eventually took practical shape, and in February, 1872, the machine was successfully tested in flight. For the time being we will confine our notice to the constructional details of this airship of the pre-Zeppelin era. To-day we would describe it as being of the non-rigid class. In form its gas bag was circular in cross section and lenticular in elevation, its midship area being 154 square metres and its length 42 m. The shape of the bag was maintained by preserving the gas at a pressure slightly greater than atmospheric. The idea of suspending a longitudinal girder beneath the whole length of the gas bag—the principle of the "semi-rigid" airship—was considered, but was not applied. Inside the gas bag there was a ballonet or "swimming bladder," into which air could be introduced for the purpose of making good the volume lost by the escape of gas. The car was suspended by silken cords at a considerable distance beneath the gas bag. The rudder was attached to the after end of the gas bag and was operated by means of cords passing over pulleys downwards to the car. The propeller was mounted at the after end of the car and was driven by the application of manual power to a crank handle. In order to calculate the speed at which it might be possible to propel the vessel its principal parts were considered separately and an estimate was made of their resistance in terms of the resistance of a thin plane of corresponding projected area. It was known from experiment that a thin plane exposed perpendicularly to a current of air moving with a velocity of 8 kiloms. an hour—the anticipated speed of the airship—experienced a pressure of 0·665 kilo. per square metre. The balloon without its netting, it was estimated, would experience a resistance equal to one-twentieth of the resistance of a thin plane of the same area. The ratio for the car and accessories was taken at one-fifth and for the netting and cords at one-half. The total resistance determined in this way was given as 9·800 kilos. With a two-bladed screw 8 m. in diameter it was calculated that sufficient power would be developed to overcome the resistance at the desired air speed if the screw were rotated at about 21 r.p.m. Four men working at the crank handle driving the screw would, it was estimated, be sufficient to furnish the required power.

BOOKS RECEIVED.

The Modern Diesel. London : Iliffe and Sons, Ltd., Dorset House, Tudor-street, E.C. 4. Price 2s. 6d. net.

Ordeal by Banking. By W. Allen Young. London : Cecil Palmer, 49, Chandos-street, W.C. 2. Price 2s. net.

Compression-ignition Engines for Road Vehicles. London : The Temple Press, Ltd., 5–15, Rosebery-avenue, E.C. 1. Price 2s. 6d. net.

Selling Costs and Records. By W. A. Smith. London : Moore's Modern Methods, Ltd., 12, St. Bride-street, E.C. 4. Price 3s. 6d. net.

A History of Fire and Flame. By Oliver C. de C. Ellis. London : Simpkin, Marshall, Ltd., Stationers' Hall-court, E.C. 4. Price 15s. net.

Estimating. Second edition. By T. H. Hargrave. London : Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 7s. 6d. net.

Directory of Shipowners, Shipbuilders, and Marine Engineers, 1932. London : The Directory Publishing Company, Ltd., 33, Tothill-street, S.W. 1. Price 20s. net.

Lubricating Oil Tests and their Significance. By J. E. Southcombe, M.Sc. London : Henry Wells Oil Company, Ltd., 736–9, Salisbury House, E.C. 2. Price 2s. 6d. net.

Submarine Telegraphy. By Ing. Italo de Giuli, translated by J. J. MacKichan, O.B.E. London : Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 18s. net.

Foundry Work and Metallurgy. Volumes I. and II. Edited by R. T. Rolfe, F.I.C. London : Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 6s. each volume.

Pitman's Electrical Educator. Three volumes. Edited by Sir Ambrose Fleming, M.A., D.Sc., F.R.S. London : Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 72s. net.

Witwatersrand Mining Practice. By G. A. Watermeyer, B.A., A.R.S.M., and S. N. Hoffenberg, M.Sc., B.Sc. Johannesburg : Hortors, Ltd., P.O. Box 1020, South Africa. Price 45s. net.

Chemical Engineering and Thermodynamics Applied to the Rotary Cement Kiln. By G. Martin, D.Sc., Ph.D., &c. London : Crosby Lockwood and Son, Stationers' Hall-court, E.C. 4. Price £1 11s. 6d. net.

Contour Geometry, and its Applications to Earthwork Design and Quantities. By A. H. Jameson, M.Sc. London : Sir Isaac Pitman, Sons and Co., Ltd., Parker-street, Kingsway, W.C. 2. Price 7s. 6d. net.

Specification : for Architects, Surveyors, Civil Engineers, and for all Interested in Building. Edited by F. Chatterton, F.R.I.B.A. London : The Architectural Press, 9, Queen Anne's-gate, S.W. 1. Price 10s. 6d. net.

British Industries Fair, Birmingham

No. III.*

SHELL-MEX AND B.P., LTD.

WITH the object of demonstrating how oil fuel can be used economically for various engineering purposes, there are exhibited on the stand taken by Shell-Mex and B.P., Ltd., of Britannic House, Moorgate, London, E.C., oil-fired furnaces for heat-treatment, for ferrous and non-ferrous metal melting, for forging and stamping, for rivet-heating, for cooking, varnish boiling, bitumen spraying, and other purposes, and automatic controls. The various furnaces are shown by a number of firms, and we give below some details of a few of the exhibits on the stand.

A portable oil burner is shown by Urquharts (1926), Ltd., of Kingsway Corner Buildings, London, and we give in Fig. 17 a sectional drawing of the device. The apparatus is simple, but it is heavily constructed to withstand rough usage. Besides the actual burner illustrated in Fig. 17, there is a small tank holding a supply of oil included in the equipment. This tank may be connected to one or more burners. The oil is delivered to the burners by compressed air. For the operation of the burner all that is necessary is that both the tank and the burner itself should be connected to an air supply, the pressure of which is about 100 lb. per square inch. Air is allowed to enter the top of the oil tank through a reducing valve, and the flow of oil to the burner is regulated by an air escape valve through which the air should be just "blowing off" in order to ensure a steady supply of fuel to the burner. The pressure of the air at the burner nozzle depends, of course, on the size of flame required and the amount of oil to be atomised. This burner is of the atomising type and it is claimed that it is very much more powerful than any vaporising burner. It lights readily from cold with a small torch and leaves no deposit whatsoever on the part heated. The container for the fuel oil has a capacity of 5 gallons, which is sufficient for four burner-hours at average load.

An oil-fired rivet-heating furnace, 24in. by 14in. size, giving an output of 250 rivets at an oil consumption of 2 gallons an hour, and an annealing or case-hardening furnace are shown by Burdons Ltd., of Scotland-street, Glasgow. In the case of the latter furnace, which has inside dimensions of 40in. by 30in., a temperature of 900 deg. Cent. can be maintained at a consumption of 2 gallons of oil per hour. The flame cannot impinge on the materials in the working chamber. From the combustion chamber the hot gases pass upwards through flues arranged along each side of the furnace to the working chamber, being drawn thence into a regenerative chamber. The burner is of simple construction, giving a heating flame which the makers state is not harmful to the brickwork. The type of flame can be altered from neutral to oxidising by the adjustment of the air and oil cocks, and the air used for combustion is heated by the waste gases from the furnace in the regenerative chamber. Two interesting furnaces shown by the International Furnace Equipment Company, Ltd., of Imperial Works, Birmingham, are illustrated in Figs. 18 and 19. The first of these is for heat-treatment processes. It possesses the feature of a radiant diffuser wall which distributes the heat in the heating chamber and thoroughly mixes the burnt gases. The radiant wall is really the side walls of the furnace chamber and consists of high refractory tiles perforated with a very large number of comparatively small holes, through which the hot gases from the under-fired combustion chamber are admitted to the furnace chamber. In this way the gases are thoroughly mixed, a homogeneous atmosphere is obtained, and even distribution of heat is achieved. The walls also become radiant over their whole area. The temperature of the furnace can be regulated between 500 deg. and 1000 deg. Cent. and can be easily maintained. The makers claim that at any temperature within the range quoted, the CO_2 content of the furnace atmosphere can be adjusted to within a decimal point of the maximum theoretical value without the presence of any smoke. The regulation of the atmosphere is under control by means of secondary air controls on the recuperator, the temperature being regulated by means of the oil, air and damper controls. Although on the furnace exhibited all these controls are hand-operated, a device can be added which operates them automatically. The other furnace made by the firm and exhibited on the stand is for use in the forge and is capable of heating 8 lb. of steel at a consumption of 1 lb. of fuel oil. The maximum temperature attainable is 1400 deg. Cent., and the unit embodies a heat deflection hood, designed to ensure the comfort of the operator and high pre-heat of the combustion air.

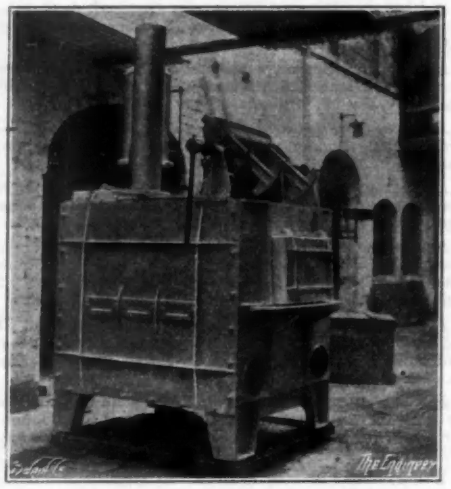


FIG. 18—HEAT TREATMENT FURNACE—INTERNATIONAL FURNACE

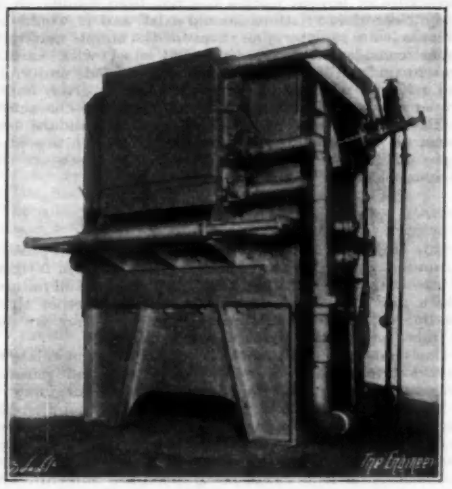


FIG. 19—FORGING FURNACE—INTERNATIONAL FURNACE

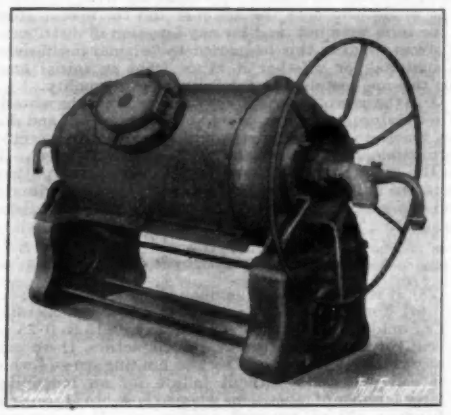


FIG. 20—BRASS MELTING FURNACE—ARMSTRONG

An interesting oil-fired, double-chamber type tool-hardening furnace is exhibited by Alldays and Onions, Ltd., of Small Heath, Birmingham. The burner utilised in the furnace is a recently developed product, suitable for working in conjunction with a fan blast for atomising purposes. The new burner, so the makers state, has been subjected to exhaustive tests, not only carried out by themselves, but also by independent users, and they claim that a considerable economy in fuel consumption has been effected. The firm claims that in the new burner perfect atomisation is obtained, and that there is excellent control of the length of the flame. A swivel flange is provided so that the burner nozzle may be turned away from the burner hole when the furnace is shut down. The furnace controls are all arranged at the end remote from the burner, so that they are always cool. In addition to the furnace, Alldays and Onions, Ltd., are showing one of their steel plate silent blowing fans for supplying the blast. The fan is of the single-stage type, and is suitable for delivering air up to pressures of 1 lb. per square inch and is claimed to be silent in operation.

In Fig. 20 we illustrate a 3½ cwt. capacity, oil-fired non-crucible type open-flame furnace, for brass melting exhibited by Sir W. G. Armstrong, Whitworth and Co. (Engineers), Ltd., of Scotswood Works, Newcastle-upon-Tyne. A special ram lining former has been designed by the firm for use in connection with the re-lining of the furnace, which it is stated renders that operation a comparatively easy matter, since, as the furnace itself is made in two parts, it is very easily opened up. The furnace, being of the non-crucible type, the material used for the lining enables, it is claimed, several hundred heats to be made before re-lining becomes necessary. The furnace is fired by two burners, one at each end of the barrel, and the flame does not impinge directly upon the sides of the furnace, nor upon the metal, and in this way the wear of the lining is reduced to a minimum. A semi-rotary movement of the barrel can be brought about by the use of the hand wheel. The operation requires very little effort and the charge of metal is rolled around the furnace and brought into contact with that part of the lining previously exposed to the heat of the flame. In this way additional heat is added to the metal. The exhibit is equipped for demonstration purposes.

Several other makers are exhibiting furnaces or equipment for furnaces, oil burners and other devices, on the stand, which is well worth a visit by any engineer interested in oil-firing and the use of fuel oil.

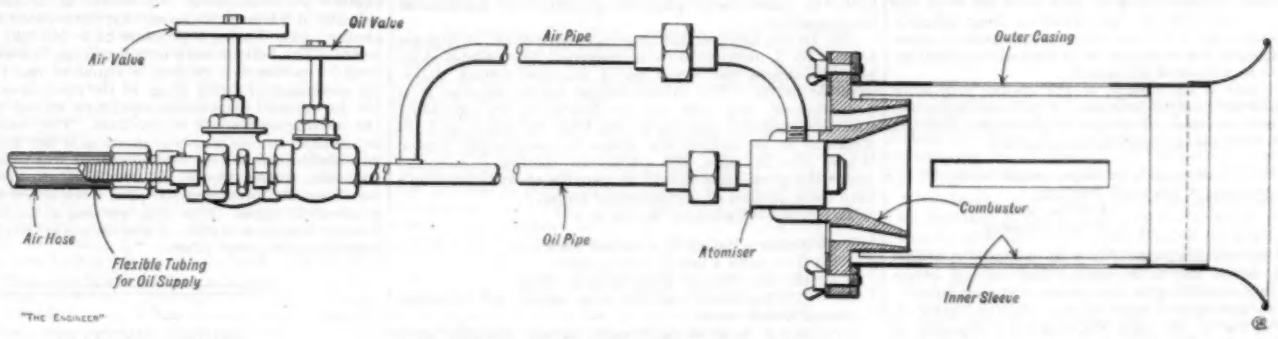


FIG. 17—PORTABLE OIL BURNER—URQUHARTS

THE GENERAL ELECTRIC COMPANY.

Some of the latest machinery employed in the manufacture of Osram lamps is to be seen in operation on the stand of the General Electric Company, of Witton, Birmingham. Skilled operators from the works at Hammersmith and Wembley are demonstrating some of the most important processes in the manufacture of Osram lamps, such as filament winding, exhausting, gas filling, capping, and testing. Fractional horse-power motors and various electrical domestic appliances are shown. Four overhead reflector units, as employed in cinema studios, serve to illuminate the stand, two containing twenty 500-watt lamps, whilst the other two each contain six 1500-watt lamps. Spot-lights and flood-lights consume in all over 40 kilowatts. "Celeon" electric signs in different colours at the four corners of the stand serve to attract attention to the G.E.C. exhibits.

The domestic exhibits consist, among other things, of cooking apparatus, cleaners, floor polishers and electric fires, and demonstrations of electric cooking on a new "Magnet" table cooker are being given on the stand of Hague and Mackenzie. "Magnet" Bakelite bells and accessories, together with the G.E.C. luminous indicator system and the Gecophone hand combination telephone made in Bakelite are shown, the latter being a new form of subscriber's telephone in which the handle and the receiver and transmitter

* No. II. appeared February 26th.

cases are moulded in one piece. Conduit and conduit fittings are also on view, some being finished in the new silver-grey finish, known as Silverlac, which has an attractive appearance. The new cable separator box—Fig. 21—has been designed to facilitate wiring in a building in which it is not certain at the time of erection whether each floor will be let out as one office or not. It consists of an adaptable junction box, with an interior which provides separate channels for the lighting, power and telephone networks.

The electric lighting accessories display covers all types of Bakelite and metal switches, wall plugs, lamp holders, adapters, &c., and also includes a wide range of "Landor" switches embodying an underslung movement giving an extremely long and rapid make-and-break. Recent developments are the "Silent Landor" switch, fitted with rubber buffers to minimise noise; a double-pole "Landor" switch and the "Deeble" slotted-base switch, which allows wiring to be done from the front after the switch has been mounted on the block. The wiring systems recommended by the G.E.C. are also on view, namely, the "Magnet" bond system for metal-covered installations, and the "Magnet" C.T.S. system for "all-insulated" work.

A 132 kV outdoor sub-station erected outside the main building represents part of an "L N E" type sub-station and comprises a 132 kV, three-phase, oil circuit breaker, and a set of 132 kV rotary isolating links mounted on concrete pedestals. The oil circuit breakers have a capacity of 300 ampères at 132 kV, and have four breaks per phase. The three breakers forming a three-phase unit are operated simultaneously by a system of levers mechanically connected to a powerful solenoid housed in a waterproof steel case at the side of the breaker. Means are provided whereby each phase can be operated manually, although, under normal conditions, they are remotely controlled from the power station. The breakers are connected to the rotary isolating links, which are opened and closed mechanically, and an interesting feature of the links is the chopping action imparted

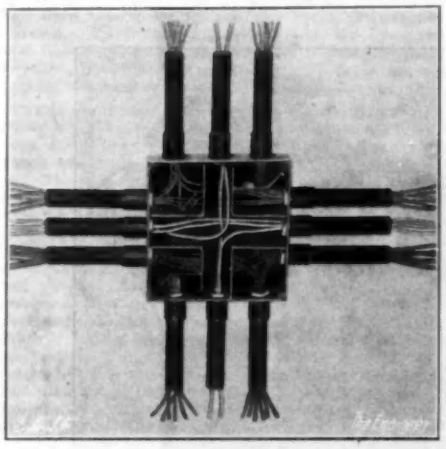


FIG. 21—CABLE SEPARATOR BOX—G.E.C.

to the blades as they enter and leave the fixed contacts by the "off-centring" of the moving post. The connections from the links are led to one side of a typical transmission tower, representing one circuit of a double-circuit line.

MINING AND INDUSTRIAL EQUIPMENT, LTD.

As the name of this firm, Mining and Industrial Equipment, Ltd., with offices at 11, Southampton-row, London, W.C. 1, would indicate, the exhibits on its stand are principally concerned with mining and its allied activities. Thus there are a four-roller Raymond mill, actually at work grinding limestone and gypsum, a 10ft. square Rovack vacuum filter, a 4ft. by 7ft. Hummer vibrating screen, and a model of an Andrews de-slimer, for separating slimes from coarse material.

There is also a rubber-lined grit pump, of which we give a perspective view in Fig. 22, intended for pumping water loaded with grit, such as that handled in clay pits, alluvial tin propositions, and so forth. Such pumps and discharge pipes have, of course, been used in the East for some time, but we believe that most of the plant has come from America. The new pump is entirely British.

Rubber is well known as a material very resistant to abrasion and erosion—witness the long life of conveyor belts carrying heavy and angular ores—and this grit pump has been so designed that every part of its interior that comes in contact with the material being pumped is protected by a coating of rubber. Wear on the gland is prevented by special vanes on the back of the impeller, which are plainly shown in the sketch and which cause a centrifugal force which drives back any particles of grit that may tend to get behind the impeller. Arrangement is also made for feeding in a small quantity of clear water to be acted upon and forced outwards by these vanes.

In order to avoid any trouble should any grit remain behind the impeller when the pump stops, a special grit repeller is also provided on the boss of the impeller. It consists of a pressed steel cup which fits into a recess in the casing. This cup prevents any grit getting into the gland. When the pump is started up again the centrifugal force created by this cup drives back any grit which may have reached it. The grit pump is designed for easy replacement of all wearing parts. No special tools are required, an ordinary spanner and screw-driver being all that are necessary. When the front cover is removed the impeller and renewable end plates can be instantly withdrawn.

A complete 4in. grit pump is shown on the stand,

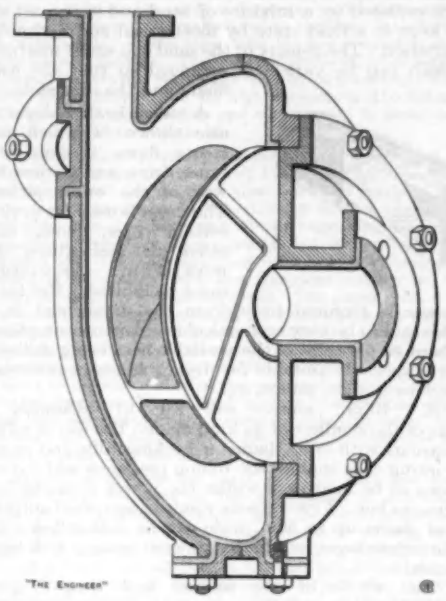


FIG. 22—GRIT PUMP—MINING AND INDUSTRIAL

together with a set of spare parts so that the construction of each part may be studied.

BROOKES (OLDBURY), LTD.

The direct motor-driven, three-roller, coiling machine, which we illustrate in Fig. 24, forms an interesting exhibit on the stand taken by Brookes (Oldbury), Ltd., of Oldbury, near Birmingham. It is designed to handle heavy coils of metal up to a maximum width of 18in. and a maximum thickness of ¼in., and can produce either a closed or open coil. The finished coil is delivered from the machine at floor level. An open coil is obtained by bringing into operation a ratchet feed, which works in a direct ratio to the speed of coiling of the rollers, increasing the diameter of the coil as the strip metal feeds through. The design of the machine is such as to permit coils to be formed with a straight end, with the object of overcoming the difficulty sometimes met with in rolling mill practice in opening up coils of heavy gauge material after annealing when the operator requires to feed the metal through the rolling mill. An interesting feature of the machine is the provision of an additional roller on the outgoing side, which can be rapidly and easily brought into use and makes up with the bevelling rollers a set of four rollers acting as a straightening device. By reversing the motion of the mill and bringing this additional roller into operation, a coil of metal can be uncoiled after annealing. The receiving rollers on the bottom cradle are driven and are adjustable in height relatively to the bending rollers. Each has independent adjustment, so that they can be set in such a way that the

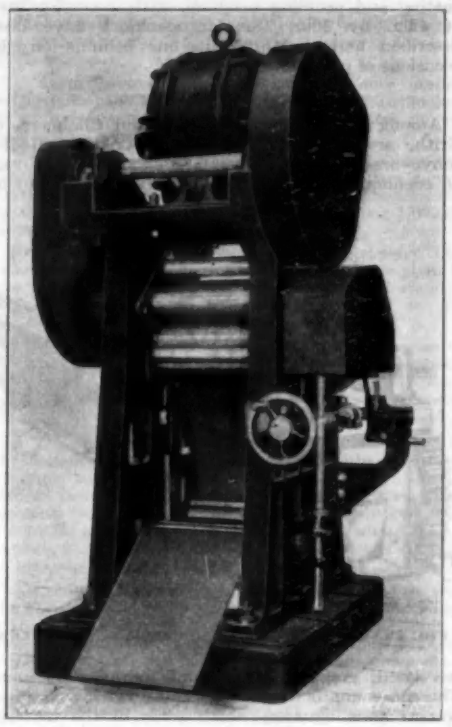


FIG. 24—COILING MACHINE—BROOKES

completed coil is either left in the cradle or tipped out on to the floor.

HANCOCK AND CO. (ENGINEERS), LTD.

Oxygen-cutting machines are being further and further adapted for really accurate work. Not so very long ago the hand cutter was the only tool of the kind in existence, and it is a far cry from that instrument to the recently produced oxygen-cutting machine made by Hancock and Co. (Engineers), Ltd., of Croydon, and illustrated in Fig. 23. The new tool is comparable in accuracy with many machine tools. It is named by the makers the Simplex Universal Profiling Machine, and has a cutting area

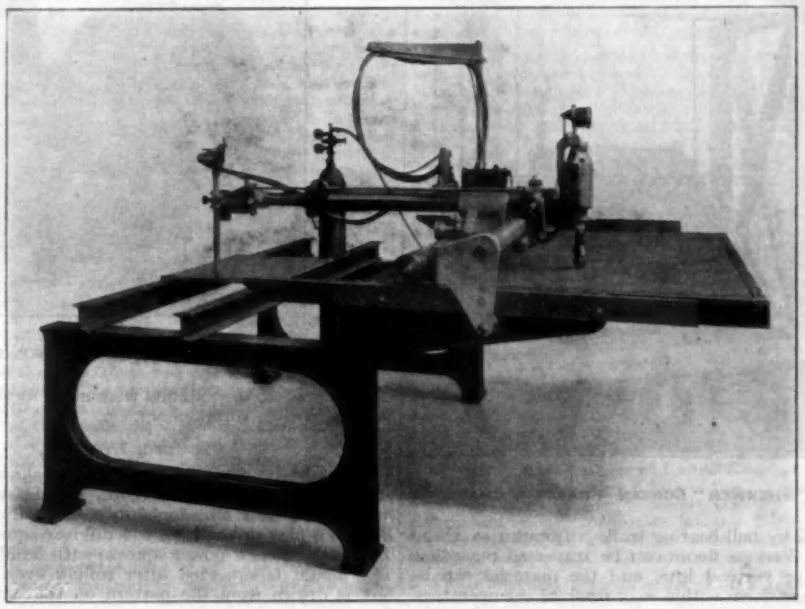


FIG. 23—PROFILING OXYGEN CUTTING MACHINE—HANCOCK

of 60in. by 40in. in metal up to 8in. in thickness. Straight lines, either vertically or at a bevel, and also circles, may be cut automatically and the electric tracer head is equipped for use either with a drawing, with a template of strip aluminium, or with a wooden template. The table is double-sided and capable of swivelling so that it may be used for operation with a drawing or a template. The controls of the gas, the heating and cutting oxygen, and for the vertical adjustment of the burner and the switches for starting, stopping and reversing the motor, can all be operated from either side of the machine.

An indicator is fitted on the tracer head by which cutting speed in inches per minute is shown. The machine is to be seen in operation.

Besides the above machine, which, being new, is attracting much attention, the firm is exhibiting several other oxygen-cutting machines, including a 10ft. longitudinal profiling machine and a direct-cutting and profiling machine, with a cutting area of 42in. by 30in. Similar machines have been described and illustrated in our columns on the occasions of previous exhibitions.

Fraser and Chalmers.

Among the exhibits of Fraser and Chalmers, of Erith, are two 16ft. Fraser and Chalmers-Redler conveyors—Fig. 25—which are claimed to provide an economical solution to the problem of conveying

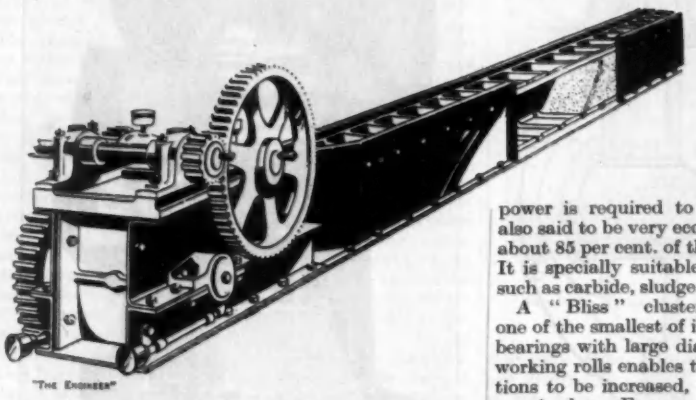


FIG. 25—CHAIN CONVEYOR—FRASER & CHALMERS

powdered, granular, and small lumpy substances. The conveying is done on a chain, which consists of special links between which some of the material collects to form a belt on which the remainder is conveyed in a quiescent mass. As the conveyor is enclosed it is weather and dust-proof. Over small spans it is self-supporting and can be extended very cheaply. As the speed is slow the wear and tear are negligible. The power consumption is also very low, both the conveyors shown being driven by one 1 H.P. motor.

Around two sides of the stand a Webb conveyor runs. This is a type of conveyor that has recently been introduced into this country for the circulation of raw material and work in the course of production in factories. It acts on a well-known principle, but the efficiency has been improved by the use of ball bearings and an endless articulated chain

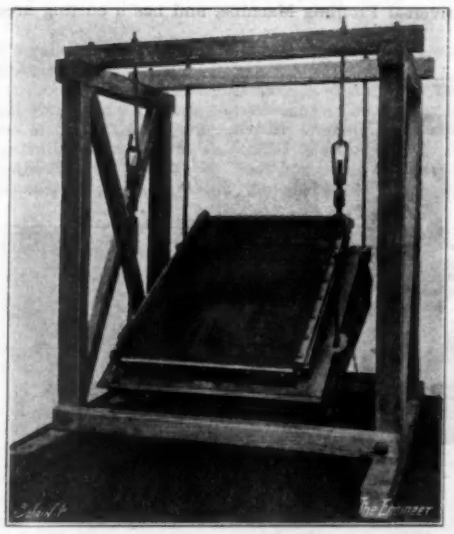


FIG. 26—"SHERWEN" SCREEN—FRASER & CHALMERS

suspended by ball-bearing trolleys from an overhead runway. Various floors can be traversed regardless of turns or vertical lifts, and the material can be brought low down within easy reach of the operators, or be elevated when headroom is required. The conveyor shown is driven by a ½ horse-power motor.

The Sherwen screen—Fig. 26—is provided with a new type of vibrating mechanism. The moving frame is mounted on spring seats composed of hickory or ash, and is given 2400–3000 vibrations per minute by two solenoids controlled by a make-and-break mechanism. The amplitude and rate of vibration, and the screen angle, can be adjusted during operation. There are no bearings, pulleys, belts or shafting, and the power consumption is very small. The same principle has been successfully applied to concentrating tables for coal, sand, slimes, &c.

The more usual types of conveyors and screens are exemplified by a 20ft. portable conveyor and a single-deck Gyrex screen, both of the Robins type, and driven by 3 H.P. and 5 H.P. motors respectively. The conveyor is claimed to be economical in first cost and maintenance; the frame is self-cleaning, and the troughed belt enables abrasive material to be handled without wear on the edges. Gyrex screens are applicable to almost any screening job.

A model washer exhibited demonstrates the principle of a patented sand floatation process of washing coal which has recently been introduced, the process being a commercial application of the laboratory float and sink tests which are used for determining the washability of coal. The expensive, high-density chemical solutions used in the laboratory are replaced by a mixture of sand and water, which is kept in a fluid state by mechanical and hydraulic agitation. The density of the sand and water mixture, which can be varied, is arranged so that the coal floats and the dirt sinks.

A steam-heated dryer is also shown in which the steam flows through the inner drum and returns by way of the outer jacket. The dryer is used for drying certain ores, coal, and other material where the maximum temperature must be limited. But little power is required to operate the dryer, and it is also said to be very economical in steam consumption, about 85 per cent. of the available heat being utilised. It is specially suitable for drying adhesive material, such as carbide, sludge, &c.

A "Bliss" cluster roll—Fig. 27—exhibited is one of the smallest of its kind made. The use of roller bearings with large diameter backing rolls and small working rolls enables the rolling pressures and reductions to be increased, whilst the power consumption remains low. Fewer passes result in increased output, and sheets up to 50in. wide can be cold-rolled with the advantages of ductility, even gauge, and high finish.

The whole of the motors and control gear

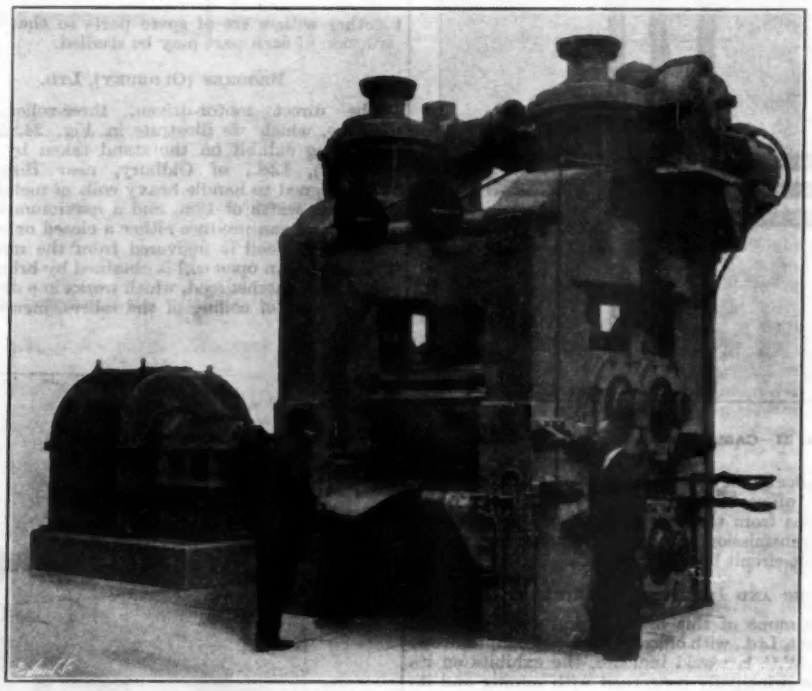


FIG. 27—"BLISS" CLUSTER ROLL—FRASER & CHALMERS

used to operate the exhibits were made at the G.E.C. Witton Works, Birmingham.

Pneulec, Ltd.

A number of foundry machines are shown on the stand taken by Pneulec, Ltd., of Mafeking-road, Smethwick, near Birmingham, and we illustrate in Fig. 28 a new production, the rollover squeeze strip. This machine is a power squeeze with hand rollover. The mould is squeezed after rolling over, and the box is drawn from the pattern on the downstroke. An arrangement built around the equaliser on the squeeze table causes the mould to roll automatically on to the main conveyor without handling. The turnover table is so arranged that the load is well balanced and little effort is required for rolling over or rolling back.

Two sand-preparing plants are to be seen. One, known as the Silkysand disintegrator, is designed primarily for the preparation of a fine grade facing. The work of conditioning is performed by a number of pins mounted on a plate driven by a 3 H.P. motor. The hood enclosing the disintegrator is cast in two parts and each half is hinged to one of the two supports of the overhead motor. In this way easy access to the pins is obtained. The pins are the only parts worn by the sand in the whole machine, and each can be renewed in about one minute. The disintegrator may be suspended from a crane or rested upon legs. The other sand-preparing plant, the Pneulec Royer, has been shown at previous exhibitions

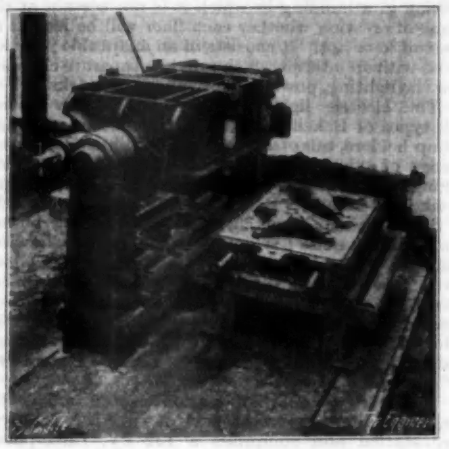


FIG. 28—ROLLOVER SQUEEZE STRIP—PNEULEC

and will be familiar to most foundrymen. The model exhibited has some minor improvements.

Ellison Insulations, Ltd.

Ellison Insulations, Ltd., a subsidiary of George Ellison, Ltd., the electrical switchgear manufacturers, is showing specimens of synthetic resin varnish products for electrical and mechanical uses. The standard material manufactured is marketed under the trade name of "Tufnol" and is made up, primarily, in the form of tube, sheet, and bar, and from these products gear wheels and other component parts are produced. "Tufnol" is made either as a paper-base or fabric-base material, depending upon the use to which it is to be put, but for general electrical purposes the paper-base material is advocated. Owing to the wide and varying fields in which an insulating material is required, "Tufnol," both with a paper and fabric base, is again subdivided into various grades, each suitable for a particular purpose. Examples of all forms of "Tufnol" tube and sheet are being shown, and the machining qualities of "Tufnol" are made apparent by the wide range of machined component parts being displayed. "Tufnol" tubes are moulded after being rolled, and it is stated that this process has the effect of making the tube material almost homogeneous, a quality that is unobtainable in tubes that are merely rolled. The advantage of this process is that it obviates the need for an outside varnish coat, with the result that "Tufnol" tubes may be machined or sawn without their electrical properties being impaired. "Tufnol" fabric base material is mostly used for gear wheels, of which several types are being displayed, although it is frequently employed for electrical and mechanical purposes where a material of exceptional mechanical strength, proof against oil and water, is necessary.

(To be continued.)

Railway and Road Matters.

AT the annual meeting of the Metropolitan Railway Company on February 18th, the chairman said that the company was paying a lower price for sleepers and rails than was paid before the war.

THE last of the cars with manually operated doors on the tube railways have now been withdrawn from traffic. The opening and closing of the doors by the train conductor from his compartment is now universal.

WITH the help of the Development (Loan Guarantees and Grants) Act, 1929, the railway companies undertook, in order to cope with the unemployment difficulty, to carry out various schemes of improvement. The later necessity for economy has forced the Government to modify its good intentions, and some of the intended works are not now going forward. Those on the "Underground" system which have been so cancelled are the improvement of the stations at King's Cross, Russell-square, Edgware-road, Post Office, and Sloane-square.

HAVING been requested to make an announcement as to privately owned wagons, Brigadier-General Baring, at the Southern Railway meeting on February 29th, in a written speech read in his absence owing to illness, said that so far as the Southern Railway was concerned, the saving to be effected by the elimination of all privately owned wagons would be much smaller than was generally thought. He added that the Standing Committee on Mineral Transport—of which, by the way, Colonel Szlumper, the assistant general manager, was a member—came to the conclusion that the system of private ownership should not be immediately terminated, and that the services now rendered by the various wagon-hiring organisations should not be transferred to the railway companies or to a common wagon pool.

SPEAKING at the Great Western Railway annual meeting on February 24th, Lord Churchill, the chairman, said that the company was now equipping the whole of the docks with hoists and conveyors capable of dealing with 20-ton wagons and fitted with the latest anti-breakage appliances. He was sorry, though, to say that little, if any, progress was being made by the colliery companies in the direction of providing the 20-ton wagons. Inquiries had shown that the colliery companies desired to use the high-capacity wagon, but in the present circumstances they were unable to finance any large programme of renewals. Until that difficulty could be overcome a very necessary and desirable reform must remain in abeyance, but it was hoped that certain proposals which were under consideration would lead to a solution.

THERE are three stations in the popular seaside resort of Blackpool. The earliest was that at Talbot-road, on the north side of the town, which was opened in 1846, when a branch was made from Poulton on the Preston-Fleetwood line. The other two—the Central and South Shore—were brought into use on April 6th, 1863, when railway communication along the coast line was opened from Lytham to Blackpool Central terminus on the south side. Early in the present century a direct line was opened from Kirkham to the South Shore station and the name of the latter was then changed to Waterloo-road. It is now officially announced that, in future, Talbot-road is to be known as Blackpool (North) and Waterloo-road as Blackpool (South). It is to be presumed that the London, Midland and Scottish Company has good reasons for making the change, but it is safe to anticipate that for many years to come nine out of every ten of the hundreds of thousands who journey to Blackpool each year will adhere to the old name of Talbot-road.

THE London, Midland and Scottish Company's report for the year 1931 shows that the reduction of £4,340,462 in the expenditure on railway working, i.e., exclusive of the ancillary businesses, to offset a drop of £5,018,026 in the receipts, was contributed to by the various departments as follows:—Maintenance of way and works, £571,459; maintenance of rolling stock, £1,180,615; locomotive running expenses, £980,223; traffic expenses, £1,373,473; general charges, £83,308; compensation for accidents and losses, £75,835. The expenditure was reduced by 7·79 per cent., as against a loss of 7·35 per cent. in the receipts. The total engine miles was reduced by 4·9 per cent. and the total engine hours by 6·4 per cent. Of the "other businesses," steamboats brought in a profit of £159,362, as compared with a profit of £132,935 in 1930, and hotels, refreshment rooms, &c., had net receipts of £278,433, as compared with a profit of £376,649 in 1930. It may be of interest to note that this department had a loss of £360,000 in receipts, but was able to reduce its expenditure by £260,000.

THE engine shed of the London, Midland and Scottish Company at Nottingham is at the west end of the station, and locomotives going towards the station leave the engine shed by a connection with the down goods line at Mansfield Junction signal-box, then reverse and pass by a through road on to the up goods and the up passenger line. Just as dawn was breaking on December 7th last two light engines coupled together were sent towards the station along the up passenger line. The next signal-box is Wilford-road, where the drivers found the home signals at "danger." Unfortunately, the signalman at Mansfield Junction had failed to send to and receive from Wilford-road the necessary block signals, and so the man in the latter box was unaware of the arrival of the engines. Unfortunately, also, owing to the signal cabin being close to the abutment of an overbridge, that man cannot see anything standing at the passenger line home signals unless he opens the window and leans well out. Owing to the engines not being recorded on the block instruments, there was nothing to prevent Mansfield Junction offering and Wilford-road accepting another train, and that was done with a passenger train, which consequently ran into the light engines, but luckily with little personal or material ill-effects. Lieut. Colonel Anderson inquired into the accident and recommends a starting signal for Mansfield Junction, controlled by the Wilford-road block instruments, and track circuit at Wilford-road to indicate when the line at the home signals is occupied. The inspecting officer also suggests that by long-distance point operation and track circuit, the functions of the two signal-boxes could be combined.

Notes and Memoranda.

TESTS to determine the ability of a new type of transmission tower to withstand unusual strains have been made by the New York Power and Light Corporation by weighting the conductors with sand bags to simulate ice loadings and subjecting the towers to a transverse stress equivalent to the wind stresses. Then two conductors were cut in succession to determine the unbalancing effect on the tower. More than 500 sand bags with a total weight of 25 tons were used to load the spans on each side of the tower, this being the calculated equivalent weight of the ½in. of ice coating on the wires and towers. A 5-ton transverse pull on the tower was calculated to simulate the effect of a 60-mile gale. Under these tests the tower failed to show any signs of damage. The only noticeable effect of cutting the conductors was slipping of the wire in the safety clamp. The tower tested was on the company's 110,000-volt Thompson-Greenbush line and corresponds to those used on the New York City tie line.

A PAPER recently read by Messrs. W. B. Hird and J. B. Mavor before the Institution of Electrical Engineers gave an account of the progress that has been made in this country in particular in recent years in the mechanical handling of coal underground. Broadly speaking, European conditions generally were covered, but the authors contended that the best equipped collieries in Britain now compare favourably with any European colliery on the basis of output per man employed. The paper dealt with electrical conveying plant, and after describing the various types of conveyors outlined the switching arrangements necessary to enable full advantage to be taken of the various possible groupings of the plant, and detailed the special points to be attended to in the design of electrical motors for this purpose. The only alternative to electricity which has been employed to any extent for this purpose is compressed air, but figures are given which demonstrate the savings gained by the use of electricity.

NOTWITHSTANDING the rapid progress that has been made in recent years in the application of automatic printers to landline operation, and the continued efforts to apply similar methods to the operation of long non-loaded submarine cables, the syphon recorder, which requires manual translation, still is used almost exclusively in the operation of such circuits. While the recently developed loaded type of submarine cable possesses characteristics which permit of its being operated with a modified form of landline multiplex printing system, the numerous attempts to develop and apply a satisfactory direct printing system to non-loaded cables have not met with complete success. A paper read at the Winter Convention of the American Institute of Electrical Engineers outlines the various factors which enter into this problem and describes a new type of cable printer which has been developed and placed in successful operation on cables between London and New York and also between New York and points in Central and South America and the West Indies.

IN a paper read before the Junior Institution of Engineers by Mr. K. Gray, it was stated that an alloy consisting of 99·25 per cent. lead, 0·25 per cent. cadmium, 0·5 per cent. antimony, or, alternatively, 98·25 per cent. lead, 0·25 per cent. cadmium, 1·5 per cent. tin, showed greatly increased tensile strength as compared with lead. The alloy is now largely used for the sheathing of electric power and telephone cables, both land and marine, and is extensively used for the sheathing of all cables installed in H.M. ships. When applied in the manufacture of water pipes, its resistance to fatigue, increased resistance to hydraulic pressure and the resistance it affords to the chemical action of certain waters renders it of great value in domestic application. In tests undertaken for water engineers in different parts of the country it was demonstrated that the amount of lead dissolved out of an ordinary lead pipe of ¾in. bore amounted in four days to 6·76 grains per gallon, while in the same period from a ternary alloy pipe of the same size only 1·96 grains were dissolved. Due to the greater strength of the alloy, pipes made of it can be of thinner gauge metal to stand similar pressures, a saving of 30 per cent. in weight of any given length of pipe being possible as compared with ordinary lead pipe, this reduction in wall thickness reducing the cost per yard of the finished alloy pipe below that of lead pipe.

ON Friday, February 19th, Professor C. F. Jenkin delivered a lecture before the Royal Institution on "The Mechanics of Shifting Sand." He began his lecture by explaining why experiments intended to measure the pressure exerted by granular material, such as sand, failed, and showed that the failure was due to arching—a necessary consequence of the property of dilatancy, discovered by Osborn Reynolds. Models of granular material, made of a gross of steel balls, were shown, which reproduced the effects of arching and showed how it could be avoided by using suitably proportioned apparatus. The latest design of apparatus for measuring the forces on a retaining wall was shown and the results of a test made with it were described. The forces on the wall are not constant when the test is repeated again and again, but follow a cycle. The explanation of this cycle was given, and was shown to depend on the same phenomena which make the sand in an hour glass move in intermittent rushes. With this apparatus the old earth pressure theories have been tested, and the truth in them separated from the error. As a result, a revised wedge theory has been formulated, and its accuracy confirmed by over fifty tests on walls of all batters with all surcharges. The apparatus was shown to be capable of measuring the forces not only on plane walls of any batter, but also on stepped walls, and on L-shaped walls, and also of measuring the forces under water. Finally, by an ingenious device, a wall of sand had been tested and the true friction angle between two sand faces measured. The reaction—the force exerted by the wall on the sand—was described, and its importance illustrated by an account of the partial failure of a great weir in Australia. The apparatus described can only deal with one-quarter of the whole problem of earth pressures. It cannot measure the forces under a foundation, and it cannot measure either horizontal or vertical forces exerted by clay. The lecture was illustrated by experiments and mechanical and ordinary lantern slides.

Miscellanea.

THE value of the coal gas consumed in Great Britain is estimated by Mr. W. J. A. Butterfield, the Board of Trade Referee, at 50 million pounds per annum.

THE Sunderland Gas Company has made an arrangement for the supply of at least 1,000,000 cubic feet of coke oven gas with the Lambton, Hetton and Joicey Collieries at Philadelphia.

A SPECTROSCOPIC laboratory has been built inside a refrigerator at the Massachusetts Institute of Technology. It comprises a ten-room building of windowless concrete enclosed by brick and concrete walls.

THE production of aluminium by Canada is now estimated to be valued at about 4,300,000 dollars a year. Only one of the plants concerned with its production, that on the Saguenay River, is capable of generating 1,000,000 horse-power.

WE learn that the Stanton Ironworks Company, Ltd., near Nottingham, has recently completed a new plant for the manufacture on mass production lines of standard specials of 3in., 4in., and 6in. diameter sizes for use with cast iron and centrifugally made pipes.

IN the reconstruction of the railway bridge across the river Esk between Egton and Glaisdale, which was washed away in the floods of last autumn, the original span is being raised and replaced, and a new span, of corresponding length is being added, with a central concrete pier.

A TRANS-SAHARAN Technical Expedition, arranged by the French Ministry of the Colonies, recently left Algiers in order to demonstrate and experiment with French African motor fuels other than petrol, especially vegetable alcohols, palm oil and castor oil. The vehicles which are to be used are light lorries equipped with ordinary engines, but provided with carburetters specially designed to heat and volatilise the fuel.

A REPORT, just issued by H.M. Stationery Office, from the Forest Products Research Board, deals at some length with the seasoning of timber and gives as the limit of moisture content for general carpentry work, 25 per cent. For joinery and panelling work the moisture content is put at from 12 to 9 per cent. The report includes a considerable amount of information concerning the protection of timber from the ravages of decay and parasites. Its price is 4s.

THE Governors of the Heriot-Watt College, Edinburgh, have decided to proceed with the erection of the first section of the proposed extension of the College, at an estimated cost of £30,000. The proposal involves the demolition of derelict buildings at the rear of the College premises, and will enable the street-widening scheme in the Cowgate to be undertaken. Accommodation will be provided in this first section of the extension for printing, mechanical engineering, drawing offices and lecture rooms.

THE Düsseldorf meeting of the International Wire Rod Syndicate recently discussed the question of the export difficulties which have arisen owing to currency conditions. In connection with this matter, it was found impossible to come to a uniform decision concerning selling prices. The settlement of the programme of production for the ensuing quarter was also postponed until the next meeting, which will presumably be held in Brussels. The plan for the current quarter is an output of 360,000 tons. An agreement in principle is reported to have been reached between the Iweco (International Wire Exports Syndicate) and the representatives of the works merchants, as well as with the large export firms, concerning their future mutual relations.

THE first vessel to be launched on the Tees this year was launched from the Furness shipbuilding yard, Haverton Hill, a few days ago. This was the steel screw steamer "Remois," the first of two ships being built to the order of a Continental shipping firm. The "Remois" has been specially designed for the efficient carriage and handling of locomotives, rails, and other railway material, as well as wine in casks, phosphates, and general cargo. The leading dimensions are:—Length, 330ft.; breadth, 53ft.; depth, 34ft. A deadweight of 5250 tons is carried on the load draught. The propelling machinery is being supplied and installed by Messrs. George Clark, Ltd., of Sunderland, and will consist of a set of triple-expansion engines and two forced draught boilers, working at a pressure of 180 lb.

THE Commercial Secretary to H.M. Embassy at Berlin reports that he has received an inquiry for the names of United Kingdom manufacturers of cast steel plates for tool-making. The plates are to be unannealed, clean rolled 1300 mm. by 330 mm. in the following thicknesses:—0·10 mm., 0·15 mm., 0·20 mm., 0·25 mm., 0·30 mm., 0·45 mm., 0·50 mm., further details of which have been communicated by the Department to firms whose names are entered on its "Special Register." Firms desirous of offering cast steel plates of United Kingdom manufacture can obtain the further details of this inquiry, together with particulars of the "Special Register" service of information, upon application to the Department of Overseas Trade, 35, Old Queen-street, London, S.W. 1. Reference number G.X. 11,198 should be quoted.

WE are informed by the principal of the publicity department of the London Chamber of Commerce that complaints have been received from inquirers for sites and factories that they would have commenced business here, but on inquiry they had been told that the necessary labour was not available. In one case negotiations for a factory had practically been completed, the deciding factor being the supply of labour. On inquiry at the local exchange, the manufacturer was told that unskilled labour was not available. The London Chamber of Commerce suggests that it would be of advantage if all the local labour exchanges throughout the country could furnish a list of male and female skilled and unskilled applicants who would be willing to take up employment in other areas. These lists, when tabulated in London, would undoubtedly be of great assistance to future inquirers for factories and sites. The London Chamber of Commerce is now able to report that between thirty and forty factories, covering a variety of interests, have already been started within the last few weeks.

THE LOCHABER HYDRO-ELECTRIC POWER SCHEME

MESSRS. C. S MEIK AND HALCROW, CONSULTING ENGINEERS, WESTMINSTER

(*For description see page 264*).

SITE OF LAGGAN DAM ACROSS RIVER SPEAN—NOV. 29TH, 1931

LAGGAN-TREIG TUNNEL AT LAGGAN INTAKE—NOV. 29TH, 1931

L.N.E. RAILWAY DIVERSION, LOCH TREIG—JAN. 31ST, 1932

RAILWAY DIVERSION AND LAGGAN-TREIG TUNNEL OUTLET—NOV. 29TH, 1931

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NOTICES TO READERS.

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FATIGUE.

IN view of the immense amount of research which has been devoted to the subject of "fatigue," and the advances which our knowledge of it has made, it is important that the term itself should be clearly understood. Considerable interest, therefore, attaches to a Report, which we reproduce elsewhere, issued by a Committee appointed by the North-East Coast Institution of Engineers and Shipbuilders, under the chairmanship of Sir Westcott Abell. This Committee was appointed to inquire into the meaning of the word "fatigue," as applied to mild steels, and its Report is a clear and logical exposition of the early history of the word and of our present knowledge of the subject connected with it. Upon this basis an attempt is made to formulate a logical definition of "Fatigue." It is encouraging to find a body of engineers, themselves busily engaged in their own immediate practical work, displaying sufficient interest in a matter of this kind to form such a committee and to devote so much care and thought to its task. It is no criticism of their work to say that they have added nothing to the knowledge of fatigue that is already available; on the contrary, it is to be hoped that their Report will add considerably to the small amount of knowledge of the subject which is present to the minds of the general body of practical engineers. How far this lags behind the knowledge of the expert is indicated by the fact that Sir Westcott Abell's Committee thinks it necessary at the present date to set it down that in the phenomena which we include under the term "Fatigue," there is no such thing as any "crystallisation" of the metal. The fact that "crystallisation" never occurs in steel under the action of alternating or vibratory stresses has been firmly established for nearly thirty years, yet there are still engineers who are unaware of the fact. We may hope that they will give to a report drawn up by men of their own profession attention which they have failed to give to metallurgists of world-wide reputation.

If this result alone is achieved it will justify the work of the Committee, and will answer to some extent the query whether such a body was really best qualified to undertake the difficult task of arriving at a satisfactory definition of "Fatigue." It cannot and no doubt does not claim to be a committee of experts on the subject; in fact, it can scarcely claim to include a single name which is well known as an investigator in that field. But it would probably be misleading to criticise the work of the Committee from that point of view, since its Report scarcely claims to be an authoritative pronouncement, but is rather of the nature of a tentative effort put forward as a basis for discussion by experts, and also as a sound guide to thought by the engineer who is by no means an expert in this field. From the latter point of view, we can find little room for criticism. As far as it goes, the Report embodies the conclusions which have been formed by leading investigators upon the knowledge at present available; the practical engineer who bases his designs upon the facts and conclusions outlined in it will be on perfectly safe ground. In many cases he will have to go further for more detailed information if he is to make the best use of available knowledge, but if he is led to do so then the Report will have fulfilled a very useful purpose. There is, however, one section in regard to which there is room for critical discussion. It relates to the important question of the so-called "stress raisers." Here we cannot help thinking that the Report says both too much and too little. The important effects of sudden changes of section and of surface defects are rightly insisted upon, but in discussing the investigations which have been carried out on this subject we find no reference to researches which have shown that the effect of a sharp groove or notch in ductile materials, like mild steel, is much less than would be expected from the stress concentration predicted by elastic theory. This fact also affects the general theory of the "creeping flaw," *i.e.*, the fatigue crack which spreads slowly. No doubt it is true that the first formation of a crack leads to great local concentration of stress, but that stress is, to some extent, relieved by local plastic deformation, and the remaining increased stresses have again to act for a prolonged period before further cracking occurs. Microscopic observation, however, shows that the breakdown of adjacent crystals under alternating stresses has already begun before the first crystal has actually broken, so that we must think of the breakdown as occurring in groups rather than by individual crystals. In regard to another aspect of the same question, however, we think that more might have been said about *internal* stress raisers—such as non-metallic inclusions—which are very generally present in steel. The Report speaks of steel as a perfectly uniform and homogeneous material, but in practice we cannot as yet rely upon finding it so. Minute enclosures, which do not appreciably affect a tensile or an impact test, are very commonly present, and may, and often do, act as internal flaws which localise, even if they do not initiate, fatigue fractures. As engineers grow increasingly conscious of the importance of fatigue strength, it will become necessary to secure the elimination of such enclosures from steel. That is an extremely difficult problem which steel metallurgists will be obliged to face. On these and many other points we feel sure that the Report will give rise to much interesting discussion, some of which will centre around the programme for further research outlined by the Committee, as well as the proposed definition of the word "Fatigue" itself. In regard to the former, we suggest that the most urgent need is for more fundamental research in order to clear up the true nature of the processes by which repeated stresses, if they exceed a definite limit, cause ultimate breakdown of the metal. A fuller understanding of the ultimate phenomena will clear up most of the discrepancies which still appear to exist.

In regard to the definition, we have only one criticism to offer, and that is that it is not possible, even if it were desirable, to define a term like "Fatigue"—which is applicable, in its engineering and metallurgical sense, to all metals and alloys—in terms of a particular group of steels, such as those selected for discussion by the Committee. Sir Westcott Abell's Committee may have been well-advised to confine its attention to a restricted group of materials with which its members are more immediately concerned, but it cannot confine the term itself, or its application, to that narrow scope, and any definition that is to be acceptable must take into account the entire field in which the term can be rightly used. Fortunately that is not likely to cause very much difficulty, except for the fact that in a number of metals and alloys it is still doubtful whether there is any "safe range of alternating stress," at all events when they are exposed to the atmosphere. Finally, we observe that the Report makes no reference to the immensely important part which it is now known that corrosion and chemical action—even that of the air—plays in accelerating fatigue and lowering the safe range of stress. All these considerations, however, lead to the same general conclusion—that the Report is interesting and valuable, more especially to the engineer who is not an expert in the subject, while it affords much room for discussion by those who are experts. We trust that it will receive the thought and attention which it deserves.

Industries and the State.

THE *Batti Wallahs* is a London luncheon club. It meets several times a year and listens to addresses by eminent people. The members are electrical engineers and are connected, in some measure, with the sea. The club came into being years ago, when the electricians of the P. and O. Line, dubbed *batti wallahs* because they provided the electric light when navigating the Suez Canal, banded themselves together. The P. and O. element still remains, but is no longer pre-eminent. To this club Sir Ernest Benn delivered an address on Friday, February 19th. It was an excellent address, characterised by the downrightness which we expect in a prominent individualist, and the author of that attractive book, "Account Rendered," which we reviewed at some length not long since. Sir Ernest is the champion of Victorianism, and he never tires of contrasting the sturdy individualism of the 50's and 60's with the communal spirit of the present day. He detests State undertakings of nearly all kinds and is constant in his conviction that people should put more reliance in themselves and less dependence on what the Government can do for them. He deplores the destruction of capital which is going on ceaselessly through the agency of excessive taxation and exorbitant death duties, and at the *Batti Wallah* luncheon he warned us that a country which is living upon its capital is heading for ruin.

Dependence upon the State is a habit which grows upon nations. It is not a natural inclination. In every strong man, and it is only the strong who lead, there is an inbred wish to express his own personality; to be independent of others; to mould his own life and make his success dependent on his own exertions. He chafes even against associations and federations in his own walk of life. He does not willingly amalgamate with others for the purpose of research, and if he could have his way he would make his own agreements with his own workpeople and be free from the terms and contracts that are made by employers' associations. Taught by experience that "unity is strength," he combines against his will with others when necessity compels him to do so, but even before the necessity is satisfied the bonds of alliance begin to fret him. Upon this natural inclination, especially pronounced in the people of this kingdom, there has been impressed by circumstances a system which is opposed to it. Complete individualism in industry is almost extinct. Every firm is tied up with others for the control of prices, the regulation of wages, for the details of trading, for the protection and advancement of interests, and a multitude of other affairs. Modern conditions have made amalgamations of this order inevitable, and the sacrifice of liberty of action which they involve is, as a rule, not dearly bought. They are one result of the growth of industry and to quarrel with them because they remove responsibility from the shoulders of the individual to those of a corporation is fruitless. But unfortunately they have engendered a habit of mind which, we agree with Sir Ernest Benn, is the reverse of desirable. Not so many years ago the wish of every employer was to "keep the Government out of it;" now the cry is "What can we get out of the Government?" If an industry is not paying its way it demands a national subsidy; if orders are going to foreign countries it blames its Trade Commissioners; if an exhibition is required it expects the State to organise it; if it has labour troubles the Government is asked to intervene; if research work has to be performed it grumbles if a national department refuses to meet at least half the bill. Thus the independence which was a marked characteristic of British industry is gradually being undermined by co-operative efforts within the industry itself, which are excusable and desirable, and by reliance upon State aid which is explainable but undesirable.

In considering this increasing tendency to rely upon the State we cannot fail to recognise some effect of the unceasing pressure of the Socialist and the Communist. The control of electricity supply is now virtually nationalised, and it was only the defeat of the last Labour Government which prevented a similar partial nationalisation of the railways, and of transport in and around London. Such things may be the inevitable result of the vast expansion of the community, but they have a reflex action upon lesser affairs in which the loss

of complete freedom and our quondam individualism is to be regretted. The methods of the Socialist have entrapped us in a vicious circle. To do what it is asked to do the State must have money; to obtain that money it taxes industry; and industry, robbed of its means of existence and development, asks the State for funds. To find the new funds more taxation is imposed, industry again suffers and again calls upon the State. So it goes on, until we find taxation raised to the point, which it has now reached, when industry threatens to crack under the load. "It is clear," says the F.B.I. in a recent memorandum, "that the cost of government, national and local, in this country far exceeds any sums that industry can afford to provide." We are, in fact, as Sir Ernest Benn said, "living on our capital." In 1930 over 65 per cent. of the national budget was collected by direct taxation, and it will no doubt be far higher for 1931. On ordinary national expenditure—that is to say, excluding the sinking fund and the interest on debts—we spent over 320 million pounds more last year than in 1913. To continue upon that course is impossible. Industries are being deprived of their means of development, and individuals have neither money to invest nor much will to do so when the enjoyment of a large proportion of their profits is denied them. An imperative need of the day is the reduction of direct taxation. The country has responded magnificently to the demands of the Chancellor of the Exchequer; it has strained every sinew to balance the Budget. But such an effort cannot be made twice. One knows not yet how much permanent injury may have been done to industry by the strain. To use a phrase familiar to engineers, "permanent set" may have been produced; there is even danger of rupture if the load is not removed at once. A nation living on taxation with declining industries is approaching its end. The first care of the Government must be still greater reduction of expenditure and the release of industry from the weight of the burden. If thereby both industries and individuals are compelled to put more reliance in themselves and less on the State, we shall be able to look back upon the great past, on which Sir Ernest Benn so frequently turns his eyes, with less need to blush for the present.

Tyger, Tyger.

THE daily Press does not often take notice of those details of minor importance so interesting to the engineer. We have therefore been somewhat surprised at the amount of comment called forth by an advertisement inserted recently in the personal columns of several papers by an engineering firm. As technical experts, the wording of the advertisement, which naturally appeared somewhat startling to the lay reader, did not affect us with any surprise. We could see no reason why an engineering firm should not advertise that a large tiger was wanted. The association of fauna with engineering has always been intimate. To say nothing of the employment of "shires" for drawing traction engines, did not the horse figure in a locomotive entered for the Rainhill trials, and can any one forget the Brunton walking engine? The turnspit, a mechanical device, was operated by dogs; the cat played an important part in the early studies of static electricity, and one of the first experiments on refrigeration, in which a hen was employed, brought about the death of one who was both a philosopher and a scientist. We must admit, however, that the words inserted in brackets after the title of the animal—"man-eater preferred"—had a disagreeable flavour, an ominous sound. Many uses for a tiger occurred to us; as a beast of burden or of draught, for the purpose of testing a new trap, or for the reception of unwanted guests. But we could think of but one reason—for even though we recognise the difficulty of disposing of redundant staffs, we instantly dismissed that possibility—why a man-eater should be preferred. Nor were the fears we felt of the ultimate intentions of the advertisers entirely abated by the later insertion of the phrase "no cruelty," since we reflected that it was probably applied to the tiger rather than to any postulated victim. We welcomed therefore the relief afforded by the announcement of the humdrum purpose, well within the great traditions of engineering progress, for which the animal was really required. Mr. Eyston, the racing motorist, has been much impressed by the advances made in aeronautical engineering by the study of the flight and structure of birds, and he feels that much might be done to improve the performance of motor cars by a corresponding investigation of the movements of an animal noted not only for speed but for acceleration. We understand that he intends to carry out his researches at a safe distance, calling to his aid slow-motion photography.

A Notable Railway Appointment

ON March 1st, Mr. E. J. H. Lemon, lately Chief Mechanical Engineer of the London, Midland and Scottish Railway, became the Vice-President in charge of Railway Traffic Operating and Commercial. That appointment is a landmark of no small importance in the evolution of British railway organisation. The task facing the London, Midland and Scottish Railway at the time of its formation in 1923 in welding into one cohesive whole the varying organisations of eight constituent railways, not to mention many smaller concerns, was one of the biggest problems of organisation in railway history. It must be admitted that for some years very little progress was made, but the new appointment may be regarded as the finishing touch to that great operation. The appointment of one who was trained as an engineer to undertake control of the operation and commercial sections of the country's largest railway shows that much faith has been placed in the further reduction of operating expenditure through the more scientific design of train schedules and extension of mechanical appliances to decrease handling costs.

On railways abroad the appointment of engineers to executive positions is far more common than on the English railways. We may quote as examples, the late Mr. Rea, who, as President of the Pennsylvania, brought that company into Manhattan; Mr. Starbuck, the newly appointed Executive Vice-President of the New York Central Lines; Sir Henry Thornton, of the Canadian National; Mr. Ralph Budd, President of the Burlington, and at one time Chief Engineer of the Great Northern. On Continental European railways it is more common than not to find executive positions occupied by engineers, mainly civil engineers, as, for instance, Monsieur Javary, of the Nord Railway of France. In Great Britain there have also been examples, but they are comparatively few and far between: Sir John Aspinall, of the Lancashire and Yorkshire; Sir Cecil Paget, of the Midland; and the late Sir Percy Tempest, of the South-Eastern and Chatham. As a railway mechanical engineer, Mr. Lemon has done excellent work, but his most lasting achievements have resulted from his ability to organise work scientifically, whether in the production or repair of rolling stock, and it is this capacity for analysing the problem of organisation which will stand him and the London, Midland and Scottish Railway in good stead in his new sphere of activity. The appointment should give a complete quietus to the ill-considered opinion, too long accepted, that an engineer is an expensive executive; indeed, we venture to say that it is mainly the savings in expenditure which engineers have brought about which have preserved the British railways from financial disaster.

The Lochaber Hydro-Electric Power Undertaking.

IN our issues of April 25th, May 2nd and May 9th, 1930, we published a detailed description of the Lochaber Hydro-electric Power Scheme, and gave an account of the progress made with the work up to that date. The scheme, it may be recalled, is based upon the use of the waters of two adjacent lochs—Loch Laggan and Loch Treig—lying eastwards of Ben Nevis in Inverness-shire, at a height of about 800ft. above Ordnance Datum. Loch Laggan drains naturally by the river Spean which, flowing westwards, joins the river Lochy by which the united waters are carried into Loch Linnhe, an arm of the sea, at the head of which Fort William is situated. The waters of Loch Treig drain naturally into the river Spean at a point about 6 miles downstream from the exit of that river from Loch Laggan. The tapping of other sources of water is also included in the scheme, but for particulars of these subsidiary works the reader is referred to the articles mentioned above.

The general plan of the scheme centres upon the driving of a main tunnel about 15 miles long from Loch Treig westwards towards Fort William, at which the power-house and factory of the North British Aluminium Company are situated. The level of Loch Treig is to be raised by about 35ft. by means of a dam constructed across the river Treig, its outfall to the river Spean. Another dam is to be constructed across the river Spean about 5 miles below its exit from Loch Laggan—that is to say, about 1 mile above the point at which the Treig joins the river Spean. Above this second dam the river Spean will be dredged and widened. As a result Loch Laggan will be increased in length by about 5 miles, and will have the level of its surface slightly raised. The construction of the two dams will bring the top water levels of the two lochs within a foot or so of each other, Loch Laggan being at the higher level. From the dam across the Spean, or, more correctly, at the end of the enlarged Loch Laggan, a tunnel about 3 miles long will be driven to connect the waters of Loch Laggan with those of Loch Treig. From this brief outline of the scheme it will be gathered that Loch Treig and Loch Laggan will form a united reservoir from which the power-house will receive its water supply by way of the main tunnel driven westwards from Loch Treig.

Shortly before the articles referred to above were published, the main tunnel had been completed and the power-house at Fort William had been put in communication with Loch Treig. In March of last year contracts were let for the civil engineering works required to bring the full scheme as outlined above into effect. These additional works included: (*a*) The dredging of the river Spean from its exit from Loch Laggan to the site of the second dam named above; this work involves the removal of about a quarter of a million cubic yards of material. (*b*) The construction of the dam across the river Spean; this dam will be of mass concrete and will have a length of about 700ft. and a maximum height of about 150ft. (*c*) The driving of the tunnel to connect the waters of Loch Laggan with those of Loch Treig; this tunnel will have a length of about 3 miles and a finished diameter of 14ft. 6in. (*d*) The construction of the dam across the outlet from Loch Treig; this dam will be of the embankment type, 40ft. in height, and will have a concrete core wall, which will be taken down through a glacial moraine to rock at a maximum depth of about 100ft. below the surface. At present a branch of the London and North-Eastern Railway runs along the eastern shore of Loch Treig, and would be submerged by the raising of the level of that loch. The contracts now being carried out therefore include a diversion of the line to a higher level for a length of a mile and a-half.

The contractors for these additional works are Balfour Beatty and Co., Ltd. They have made good progress with the various undertakings, and have built the necessary camps, workshops, stores and access railways. Excavations for the foundations of the Laggan Dam—that is, the dam across the river Spean—are in progress, and concreting should be begun at an early date. The Laggan-Treig tunnel is being driven from the two ends, from two adits and from one shaft. One-third of its length has already been driven. The tunnel is in solid rock except for a short length at the Loch Treig end, where it passes through sand and gravel. The lining of this latter part of the tunnel is formed of cast iron segments. The trench for the core wall of the Treig dam has been carried down to the rock for about one-third of the total length of 670ft. The earthworks for the diversion of the L.N.E. Railway are nearing completion. They are of a heavy character, because of the side-long nature of the ground. The railway diversion also includes the driving of a tunnel, 450ft. in length, and the construction of a number of bridges.

Of the four photographs reproduced on page 262, the first shows the site of the Laggan dam across the river Spean and illustrates the mono-tower cranes and the temporary railway bridge which has been erected across the river. The second view illustrates the Laggan-Treig tunnel at the Laggan end, and shows the trimming gantry in position. In the third engraving we illustrate the railway diversion in the neighbourhood of the Treig dam. The fourth illustration also shows the railway diversion near the same point. In this view the existing railway and the earthworks and tunnel for the diversion are visible. In the foreground the outlet of the Laggan-Treig tunnel is to be seen. The area in the foreground to the right formed part of a loch adjoining Loch Treig which was drained by the drawing down of the level of Loch Treig following the operation of the company's power station at Fort William.

In addition to the works to which we have referred above, extensions of the pipe lines at the end of the Ben Nevis tunnel and an extension of the power-house at Fort William are also being carried out. The consulting engineers for the whole scheme are Messrs. C. S. Meik and Halcrow, of Westminster.

Obituary.

JOHN HENRY HAMILTON.

ALL those who knew personally John Henry Hamilton, of the Premier Gas Engine Company, Ltd., whose death we recorded in our last week's issue, will agree that we have lost in him one who, perhaps, more than any other engineer of his time, advanced the development of the gas and oil engine. He was strikingly original in his designs, but essentially a practical engineer, turning out accurate and precise work with a plant which, while it possessed few of the ultra refinements of the modern machine shop, fulfilled admirably the requirements of accurate, economical manufacture. He was of a modest and retiring nature, and avoided personal publicity,

but, nevertheless, was known and highly honoured by a wide circle of engineers.

J. H. Hamilton was born at the Vicarage of Estersnow, Co. Roscommon, Ireland, in November, 1858, and was thus in his seventy-fifth year at the time of his death. He was educated privately and subsequently apprenticed to Douglas and Grants of Kirkaldy, to which firm he returned after some years, and was employed on the designs of large Corliss steam engines for mill driving in India. Other firms with whom young Hamilton gained valuable experience included Laurence Sterne and Co., of Glasgow; Richard Moreland and Sons, of London, and Hayward, Tyler and Co., whilst for some time he assisted Sir Dugald Clerk with his well-known experiments on explosions in closed vessels.

It would appear that Mr. Hamilton's first contact with the internal combustion engine took place in the late 'eighties, when he was engaged upon the design and manufacture of a six-stroke gas engine, which was known as the Beck, and was built to overcome the inability to use the Otto four-cycle patent, which was successfully upheld by Crossley Brothers. The Beck engine operated on the six-stroke Linford cycle, which embodied the taking in and discharging of a scavenge charge of air before drawing in each charge of explosive mixture. It was patented by Mr. A. Rollason in 1886, and built by the Beck Gas Engine Company, of Newcastle-upon-Tyne. Its manufacture by that company was later discontinued, but the Rollason engine was built in America under that name, and English engines of the same type were made by Black, Hawthorn and Co., of Gateshead for the "Beck" Company.

In 1889, Mr. Hamilton, in conjunction with Mr. Rollason, joined with the late Mr. Alfred Wells, of Edgar Allen and Co., Ltd., of Sheffield, and other members of the Wells family, to form the partnership of Wells Brothers, of Sandiacre, near Nottingham. He thus began over forty years of active association with the Premier gas and oil engine, which continued up to his death. When Mr. Hamilton began his work at Sandiacre, the Otto patents had expired, and some outstanding results were attained by the application of positive scavenging to the Otto principle. The first patent governing Mr. Hamilton's scavenge process was taken out jointly by him and Mr. Rollason, but the later main patents were all Mr. Hamilton's, and they followed in rapid succession. The first scavenging engine was exhibited at the Electrical Exhibition which was held at the Crystal Palace in 1891. The original positive scavenge engines were of the single-cylinder pattern, with a differential piston with an enlarged front end which formed the air pump. Engines of this type up to 250 B.H.P. were built, and they are still running as satisfactorily as they have done for the past thirty years. Other interesting points in design initiated by Mr Hamilton included an improved cooling water system, the adoption of inlet and exhaust valves diametrically opposite each other, and other features which have become standard practice in this country, in America, and on the Continent. Alongside the Premier single cylinder engine Mr. Hamilton developed the tandem scavenge engine, in which the front cylinder was of the differential type and was coupled to the back piston by side rods. In 1902 Brunner, Mond and Co. ordered a large engine of this type from the Premier Gas Engine Company, Ltd., and at the same time a large Crossley gas engine. This order encouraged British gas engine builders, and an interesting discussion on the merits of the two types took place in connection with Mr. Herbert A. Humphrey's paper on "Power Gas and Large Gas Engines," read before the Institution of Mechanical Engineers in 1902. The Premier tandem engine referred to was then one of the largest in the world. The Premier Gas Engine Company, Ltd., was formed in 1898, and took over the business of Wells Brothers.

About this time Mr. Hamilton interested himself in the starting of gas engines and invented a hand pump starter which was a forerunner of the Lanchester starter. Starting by compressed air followed, and was also the subject of an ingenious design by Mr. Hamilton.

With a view to producing a lighter engine Mr. Hamilton brought out a tandem scavenging engine with a separate scavenge piston, embodying several improvements and running at a higher speed. This engine was subsequently built in two and four-cylinder units up to 2000 B.H.P. with 39in. diameter cylinders. Many engines of this type are to-day still doing excellent work. In combination with the Mond gas producer this type of prime mover enjoyed a wide use for blowing engines and electrical and industrial plants in all parts of the world.

During the war part of the plant of the Premier Company was ingeniously adapted to produce six-cylinder Rolls-Royce engines with all the accuracy and precision which are associated with that type of prime mover. We can only refer very briefly to the post-war work of Mr. Hamilton, which was characterised by the same vigour and zest with which he carried out all his earlier work. After the war the Premier Gas Engine Company, Ltd., joined forces with its earlier rival company, Crossley Bros., Ltd., and working experience was pooled. Out of this conjunction the present-day Crossley-Premier oil engine came into existence. Multi-cylinder engines of 300 to 400 B.H.P. were supplied for mining and pumping work, and the design was further extended in the form of the *vis-à-vis* engine for the driving of refrigerating plant. Mr. Hamilton's last work before retiring from the managing directorship of his firm in April, 1930, was to design a large four-crank eight-cylinder oil engine of the *vis-à-vis* type for the Middle Level Scheme of Fen Drainage.

Although he was always a protagonist of the horizontal type of gas and oil engine, Mr. Hamilton did not hold narrow views, and he, himself, built a number of successful vertical engines. He also invented and patented a new form of vertical double-acting engine with triangular connecting-rods, enabling no less than four double-acting cylinders to be worked off a single crank. This remarkable engine is running night and day still at a large Wolverhampton ironworks. Nearly all the engines we have referred to have at one time or another been described and illustrated in THE ENGINEER, and we would express the hope that it may be possible for someone closely connected with Mr. Hamilton's work to complete the task upon which he was engaged shortly before his death, of writing the story of his work.

Despite his inherent modesty, Mr. Hamilton was a man of strong individuality. He always made the calculations for his designs himself, as he did his own drawings. Mathematics was a real language to him, and the short cuts he often took were perplexing to those who attempted to follow them; but he always obtained the right answer. His originality was further shown by his ingenious adaptation of old munition tools after the war, for the specialised manufacture of his engines, many of these special machines

JOHN HENRY HAMILTON

exciting the admiration of engineers who visited the Sandiacre works.

Mr. Hamilton was buried at Holme Pierrepont, a tiny village on the banks of the river Trent, and the high estimation in which he was held by his colleagues was illustrated by the fact that over one hundred of the company's employees attended the service.

PROFESSOR ERNEST WILSON.

IT is not often that so large a number of past students mourn the loss of a teacher and friend as in the case of Ernest Wilson, Professor Emeritus of Electrical Engineering in the University of London and Fellow of King's College, who died on February 17th. Wilson worked for forty years at King's College, where he won the regard and affection of hundreds of students, with almost everyone of whom he established intimate and friendly contact. During this period he managed to carry on a surprising number of researches on very varied subjects, many of which turned out to be of importance to electrical engineering progress. He was an admirable teacher, possessing the ability to instil valuable habits of concentration and close attention to detail, and in addition, being himself a born experimenter, he was one of those who set an example of industry and enthusiasm in the laboratory and workshop, which could not but be beneficial to his students. He was gifted to an extent scarcely realised, even by his colleagues and friends, and possessed to a marked degree the vital force so necessary for a great teacher.

Perhaps his somewhat unpractical, selfless character, owing to his modesty, obscured to some extent his work and achievements, for there is little published about the man himself. As pointed out by Principal Halliday, in his appreciative letter to *The Times*, February 18th, Wilson found his heart's desire in his "boys," and "Freddie," as he was known to generations of students, holds an enviable place in the affections of King's engineers the world over.

Although he said he was a Yorkshire man, he was, in fact, born at Alford in Lincolnshire, on November 25th, 1863, where his father was a solicitor. After boyhood days spent at Alford Grammar School, he was apprenticed to Messrs. Greenwood and Batley, Leeds, where, in the shops, he took part in the building of the first Brush machine and the first Ferranti alternator constructed in this country. At the conclusion of his apprenticeship he joined the Yorkshire College, where he worked for and gained a Whitworth Scholarship, which provided him with means for proceeding to Hanover University and studying electro-technology under Professor Kohlrausch. He then joined the Woolwich works of Messrs. Siemens Brothers as a draughtsman, and there found ample scope for his industry and his inventive mind. During these years he attended evening classes at Finsbury Technical College under the late Professors Silvanus Thompson and John Perry. In 1890 he was appointed assistant to Dr. John Hopkinson, at King's College, whom he succeeded in the chair of Electrical Engineering in 1898. Retiring in 1930, Wilson devoted himself, with conspicuous success, to the task of aiding past and present students in their efforts to secure employment, and at the same time he undertook committee work for the Institution of Electrical Engineers, of which body he was elected a Member of Council in 1929. In early days he was interested in the development of electric motors, and took part in the design of the traction motors for hauling the first trains on the City and South London tube railway on the three-wire system, which was introduced by Hopkinson. For many years Wilson had in the laboratory at King's the original electric car, "Joseph Henry," built and operated by Sydney H. Short, at Denver, Colorado, in May, 1885. In 1888 he invented —British patent 18,525—the laminated field single and polyphase alternating-current commutator motor, known for years to students as "Little Billee," now to be seen adorned with a fresh coat of paint in the Science Museum, South Kensington.

In addition to being an indefatigable worker, Wilson was scarcely less active as a writer, for he published eighty of his own and over thirty conjoint papers. His well-known book, "Electrical Traction," was published by Edward Arnold in 1897, and a second edition, written in collaboration with F. Lydall, appeared in two volumes in 1907.

During the early stages of the development of wireless telegraphy, Wilson carried out pioneer work which led to several patents. Thus in Zenneck's "Wireless Telegraphy" there appears: "E. Wilson, *Electrician*, 1897, was probably the first to describe a magnetic detector." As is well known, Henry's original observations in 1842 were taken up by Rayleigh, who in 1870 discussed the effect of oscillatory electric discharges upon magnetised iron. In 1896 Rutherford described experiments made on "A Magnetic Detector of Electrical Waves and Some of its Applications," and Wilson, in 1903, stated that Rutherford had employed a moving band of iron as a detector in 1900. Wilson exhibited in 1897 a magnetic detector of his own devising, which was of novel construction, and British patent 30,846, 1897, by Wilson and Evans, disclosed such a detector provided with a re-magnetising arrangement which left the detector ready for another train of waves. A further patent—No. 14,829, 1902—was for a magnetic detector having an automatic re-magnetising device operated by a periodic current.

In 1910 Wilson, collaborating with W. H. Wilson, described an apparatus for generating trains of high-frequency waves, when connected to ordinary supply mains, of a simple and compact form embodying a rotating commutator and induction coil provided with a shunt-connected condenser and a large time constant circuit for the suppression of sparking at the moving contacts. It was in July, 1896, that Marconi introduced his method of wireless telegraphy to the engineer-in-chief to the British Government telegraph service—Sir William Preece—and, on being requested to do so, Wilson made on the terrace at King's College the first trial of the apparatus in this country.

Wilson was greatly interested in magnetic measurements, and carried out exhaustive tests on magnetic shielding, and also studied the magnetic susceptibility of feebly magnetic substances. For the latter purposes he devised an ingenious method of measuring susceptibilities of low order, found in such substances as aluminium, glass, water, &c.

The Institution of Electrical Engineers awarded Wilson the Kelvin Premium in 1921, and in 1930 a premium for his paper "The Electrical Conductivity and Tensile Properties of Light Magnesium-Aluminium Alloys as affected by Atmospheric Exposure." He was a member of the Institution of Civil Engineers and a Fellow of King's College.

HENRY DANIEL WILKINSON.

WITH much regret we have to record the death, on February 24th, of Mr. Henry D. Wilkinson, son of the Rev. John Wilkinson, of London, who was born in September, 1857, and educated at the City-road Schools, London, under Dr. Wormell.

Mr. Wilkinson was trained in London and Cornwall as mechanician and electrician for the Submarine Cable Service. For six years he was in the service of the Eastern Extension Telegraph Company in the Straits Settlements at Singapore and Penang, and during that period had charge of the erection and

maintenance of the station instruments and circuits at the latter station, the testing of cables, and the laying of land lines. He also took part in the laying of cables and in surveying and repairing expeditions in Burmese and Chinese waters. Later, after a few years' engagement as instructor at the School of Electrical Engineering, Hanover-square, he although well over the usual age, served his time as a mechanical engineer with Davey, Paxman and Co., Ltd., Colchester, and is remembered affectionately by his fellow 'prentices. He took part in the erection of 1000 H.P. of engines and boilers for this firm at the Paris Exhibition in 1889. In 1891 he was appointed and acted as mechanical and electrical engineer to the Executive of the Royal Naval Exhibition, Chelsea, and for his service on that occasion received a diploma. After acting again for Davey, Paxman and Co. at the Crystal Palace Electrical Exhibition in the following year, he was engaged by Mr. Wm. H. Massey to assist him with the drawings and specifications of the electric lighting scheme then being undertaken by the Corporation of the City of Cardiff, and in other consulting work in South Wales. Receiving the offer to act as mechanical and electrical engineer to the British Royal Commission for the Chicago Exhibition, he accepted that post, and was in America during 1893. At the close of the Exhibition he visited many of the largest cities in the United States and Canada and studied electric tramway systems, specially with regard to the return circuit and electrolytic troubles that had arisen. On this subject he read a paper before the Institution of Electrical Engineers, London, in 1894, for which he received the Institution premium. In that year he received an offer from Messrs. Willans and Robinson and joined that firm, acting as technical representative, paying close attention to the economical design of the central station plants with which that firm had so much to do. He subsequently joined the Westminster Electric Supply Corporation, acting as engineer at the Davies-street and Millbank Central stations. In 1898 he was called in by the Eastern and South African Telegraph Company as expert to study difficulties experienced with its cable at Cape Town, owing to interference from the electric tramway system of that city. He proceeded to Cape Town and investigated the matter, afterwards carrying out business of the same nature for that company in Durban and Pietermaritzburg, Natal, in connection with the projected electric tramways for the City of Durban. While in Cape Town he advised the Cape Town and Suburban Electric Supply Company on its alternating and continuous current stations, and reported to the Municipalities of Woodstock and Claremont on the effect of tramway leakage currents on the system of water supply in their district. He was joint author with Mr. A. E. Kennelly of a work entitled "Practical Notes for Electrical Students," and was author of "Submarine Cable Laying and Repairing," both in "The Electrician Series." Some years ago he set up in practice in Westminster, and became an acknowledged authority on theatre lighting. Mr. Wilkinson was a member of the Institution of Electrical Engineers, and a very old member of the Institution of Mechanical Engineers.

Leipzig Technical Fair.

No. I.

THE Leipzig Technical Fair opens on Sunday next, March 6th, and will remain open until Saturday, March 12th. Many will doubtless avail themselves of the facilities for travel and accommodation which are so carefully and conveniently arranged by the Fair authorities, and, indeed, some may receive something towards their expenses under the new scheme, whereby 1 per cent. of the value of orders placed will be reimbursed to the purchaser in order to meet his expenses. Whether this arrangement has been devised to ensure that, despite the difficult economical conditions in Britain and the disparity in money values, the number of visitors shall be kept as high as possible we do not know, but the results will be interesting.

The number of exhibitors who have stands in the Fair shows only a 20 per cent. decrease, the total amount of space taken amounting to 3,250,000 square feet, as against about 4,000,000 square feet available. Further statistics which are now available show the very slight effect on the age-long Leipzig Fair of the present depression in industry. The total number of exhibitors has dropped to about 8050, as against 9017 last year. The difference in the number of firms exhibiting in the technical section, in which our main interest lies, is still smaller, there being no less than 2021 exhibitors, compared with 2126 last year. Fig. 1 is an aerial view of the Technical Fair, and shows the neatly arranged group of buildings.

On previous occasions we have commented favourably on the care exercised in the laying out of the exhibition halls and their equipment, and the provision of foundations and crane facilities enabling the heaviest machines to be erected within them. This year there seems to be a wise tendency to avoid undue expense by showing the larger exhibits at the firm's own works, thereby avoiding the high cost of carriage. This plan has been adopted by some of the firms building large machine tools, whose stands were famous for these very large exhibits. This does not mean that progress has not been made or that any line of development has been left untouched, as our later descriptions will indicate.

This year the largest group of exhibits comes under the heading of Electrical Machinery and Appliances, which is represented by 458 exhibitors against 408 last year. The building trade exhibit reflects the interest in new building methods and appliances, there being 287 stands compared with last year's 307, while the machine tool exhibits have fallen off to 281 in comparison with 303 last year and 370 the year before. This year again there is to be an extensive show of textile machinery.

Looking over the British exhibit, we have to record a smaller number than last year, which is not remarkable in view of the exchange position, the introduction of British tariffs, and the general uncertainty with regard to future prices. We shall miss this year the fine show of machine tools made by Alfred Herbert Ltd. last year, and the interesting exhibits of the Gear Grinding Company, Ltd., Birmingham, Joseph Rhodes and Sons, of Wakefield; Lister and Co., Ltd., and other prominent British firms.

Among the 30,000 or more buyers from countries other than Germany who yearly visit the Leipzig Fair, many have previously visited the British Industries Fair. With a view to interesting foreign buyers in British goods, many firms have in the past exhibited at both Fairs, but for the reason above stated their number is less this year. We have to record, however, an important development in the decision of the British Government to take part in the Leipzig Fair this year, with a view to improving overseas trade. Following the visit to Leipzig last year of Lord Chelmsford and Sir G. M. Gillett, late Parliamentary Secretary to the Department of Overseas Trade, that Department decided to have a British Information Bureau, which would deal authoritatively with all matters relating to Anglo-German trade. The stand, which has been arranged in collaboration with the Association of British Exhibitors, of which Lord St. John of Bletso is President, is in a well-chosen position in the Ringmesshaus, one of the best placed and most up-to-date Fair houses in Leipzig. A representative collection of British trade journals is to be displayed in connection with this exhibit. British Empire exhibitors include those of Canada and India, and we are pleased to note that all the British railway companies will be represented prominently. Other British firms will doubtless show in collaboration with their German agents.

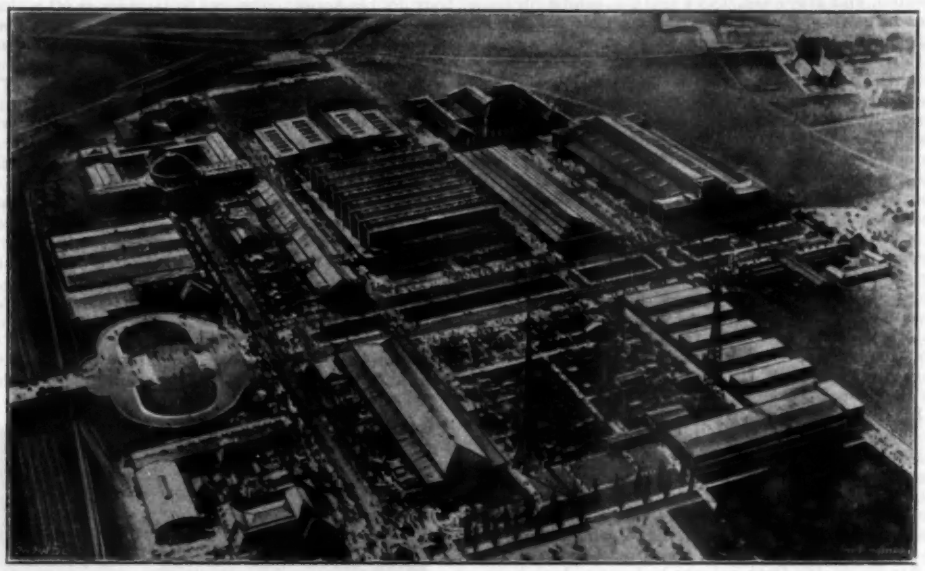


FIG. 1—AERIAL VIEW OF THE LEIPZIG TECHNICAL FAIR

As in previous years, the striking display of machine tools arranged by the German Association of Machine Tool Manufacturers is an exhibit which will compel the interest of engineers. One will perhaps miss the very large tools, but those shown will indicate the lines of recent development.

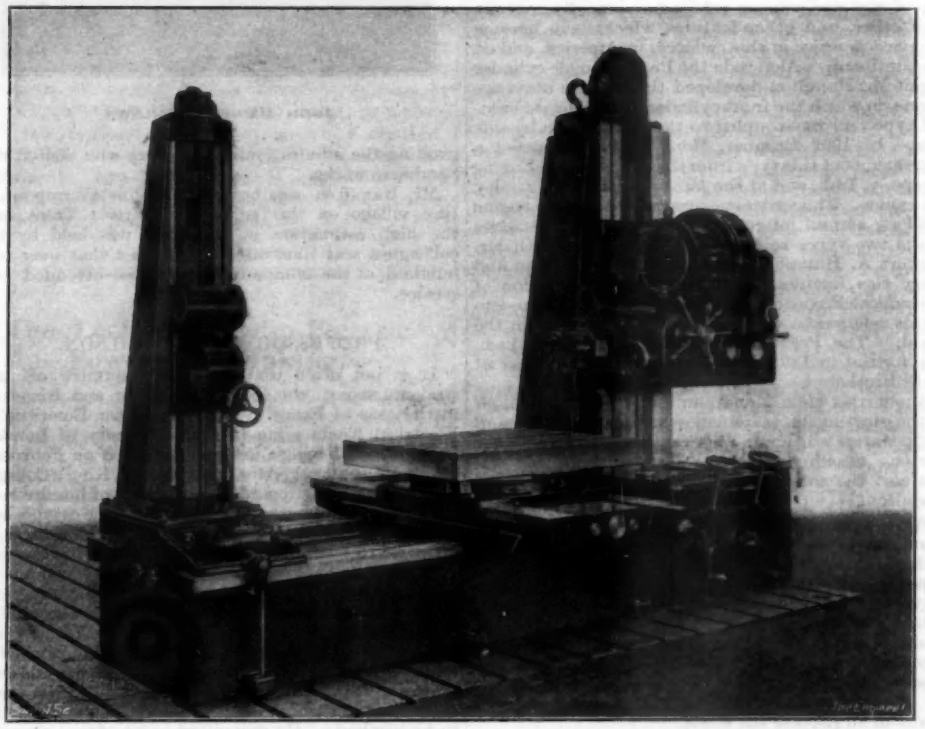


FIG. 2—HORIZONTAL MILLING AND BORING MACHINE—SCHIESS-DEFRIES

In the main it would seem that attention has been given principally to the modification of standard types of machines in order to fit them to utilise in the best possible way the new cutting tools, such as the tungsten steels and alloys of the Widia and Stellite type. Machines of this kind are to be seen on the stands of Schiess-Defries, of Düsseldorf, H. A.

Waldrich, of Siegen, Westphalia, and Collet and Engelhard, of Offenbach-on-Main, some of whose respective exhibits we have chosen for illustration. A noteworthy machine which will be shown on the stand of Schiess-Defries A.G., of Düsseldorf, is the high-efficiency horizontal milling and boring machine illustrated in Fig. 2, which has been specially designed for use with alloy tools. It is driven by a 26 H.P. D.C. motor mounted directly on the spindle-box, with a short drive to the milling spindle. The spindle has a speed range of 60 to 600 r.p.m., and by means of the reversible D.C. motor and a system of sliding gears can be run at eighty different speeds. It is mounted on large-diameter tapered roller bearings, which are inside an eight-sided sleeve adjustable in an axial direction by rack and pinion. This support slides with the spindle, and is so designed as to obviate any deflection or untrue running which might otherwise be caused by badly balanced tools when operating at high speeds. On the control panel, as Fig. 2 indicates, an incorporated tachometer and an ammeter enable both the speed and power consumption to be quickly read and checked during all operations. The push-button controls, which are marked "Left," "Stop," "Right," operate in both directions the feed and high-speed traverse movements, which are worked by a reversible variable-speed motor and an electromagnetic coupling. By this arrangement an unmachined surface can be passed over at a high speed and the previously set feed again resumed. Both the longitudinal and the cross traverse movements of the table can be automatically controlled or operated by conveniently placed hand levers. The table is 3ft. by 3ft. 11in., with a minimum height to the spindle centre of 2in. and a maximum height of 3ft. 3in. The spindle allows a milling cutter range of 2¾in. to 11¾in. diameter, and the machine is designed to remove up to 350 kilos., or about 770 lb., of cast iron per hour. As our illustration shows, a stay is provided for boring bar work, the vertical adjustment of this stay bearing being conveniently carried out by a special vertical motor, besides which there is a fine hand adjustment.

A further interesting exhibit to be shown is the 350 mm., or 13¾in., centre height universal high-speed cutting lathe, illustrated in Fig. 3, which combines the characteristics of a normal screw-cutting lathe with those of a high-speed lathe using alloy tools. A new feature is the introduction of a vertical motor for driving, whilst the quick movements of the slide rest are effected by directly attached motors. A very large range of spindle speeds is given, and the principal shafts are housed in roller bearings. On the control panel there is a new type of indicating tachometer, which enables the operator by the setting of a single index finger to the table of work diameters to read at once the correct cutting speed. A special tool holder has been developed for this lathe by the Technical High School in Aachen. It operates by a simple electrical method, and by the use of three measuring devices allows the three components of the cutting force to be read off. This apparatus, in contrast to some earlier types, is quite small in size, and it can readily be applied to any lathe.

With the extended use of tipped tools larger tool stock sections are being used, and we notice the tool grinders are now being built to accommodate sections up to 3 1/16 in. square. A new tool grinder is a double-ended machine with the automatic grinder at one end and a hollow wheel for grinding throats at the other. Schiess-Defries are also showing some of their standard vertical turret lathes, while railway and tramway engineers will find interest in the new portable rail-filing machines which are to be shown on this stand.

Some large machines will also be seen on the stand of H. A. Waldrich, of Siegen, Westphalia, one of which is the electrically driven planer illustrated in Fig. 4. It has a planing length of 6·2 m., a planing breadth of 3·22 m., a planing height of 2·72 m., and a table breadth of 2·7 m. As the engraving indicates, a new type of standards and cross beam, which are of patented construction, is used, and the cross slide, which is balanced by counterweights moving within the standards, embodies new and patented controls. There are two tool boxes on the cross slide, and two further boxes on the standards for side planing. The drive is electrical, the power being furnished by an electrically coupled D.C. variable-speed, reversing motor, giving speeds of 210 up to 1250 r.p.m., and a very wide range of table speeds in either direction. The current is furnished by a Ward-Leonard set, which has two motors in order to reduce the fly-wheel effect. As well as the fine feeds on the tool boxes, from 0·5 mm. to 13 mm., coarse feeds of 18 mm. to 100 mm. are provided. Automatic movements for both the cross slide and the side boxes are arranged, and our illustration indicates the convenient grouping of the push-buttons and the motor controls.

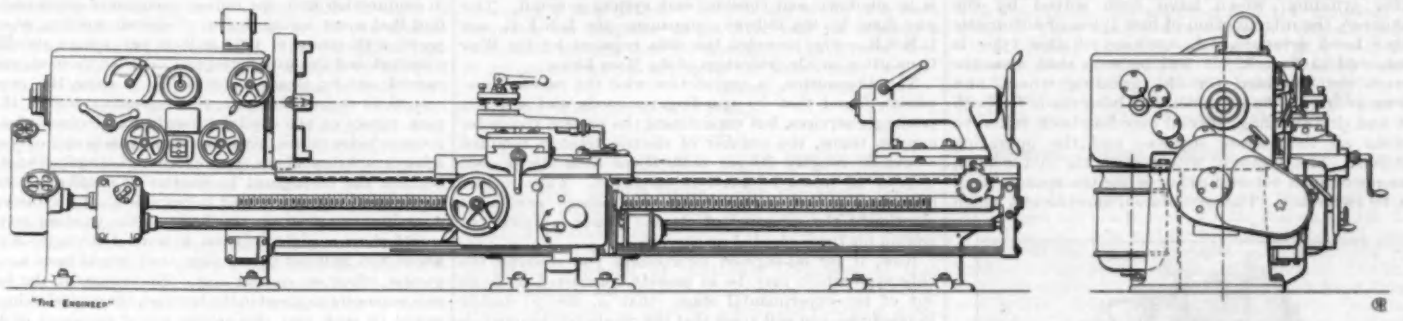


FIG. 3—UNIVERSAL HIGH-SPEED LATHE—SCHIESS-DEFRIES

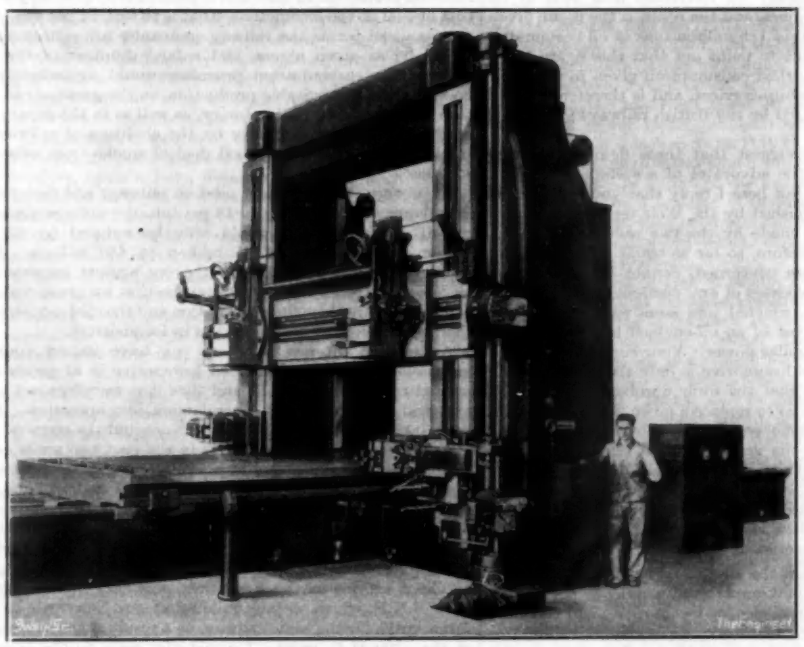


FIG. 4—ELECTRICALLY-DRIVEN PLANER—WALDRICH

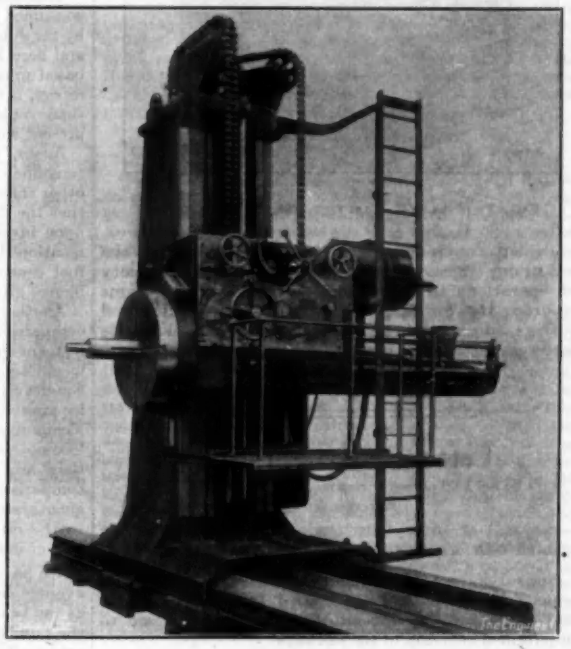


FIG. 5—BORING AND MILLING MACHINE—COLLET

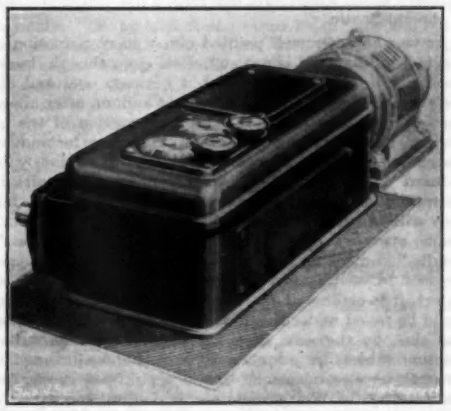


FIG. 6—HYDRAULIC DRIVE—WALDRICH

In last year's Leipzig Fair articles, we mentioned the Waldrich hydraulic drive principle, which the firm has applied to many of its machines. In Fig. 6 we reproduce a view of a standard 100 H.P. oil transmission unit of this kind. On the stand it will be demonstrated with a 50 H.P., 580 r.p.m. motor, which will give, with the hydraulic transmission, a speed range of 30 up to 700 r.p.m. without any intermediate steps, which can be controlled from any distance required. The manœuvring time from minimum to maximum speed only takes about one second.

Another firm which will exhibit some large machine tools is the Collet and Engelhard Machine Tool Company, of Offenbach-on-Main, whose British interests are represented by the Selson Engineering Company, Ltd., of London, E.C. We have chosen for description a new horizontal boring, drilling and milling machine, a view of which is reproduced in Fig. 5. A feature of the new design is the simplified operating controls and the provision of a flanged motor, coupled direct on to the saddle. The drives are effected by friction clutches, and an electric brake is fitted for quickly stopping the machine, while convenient adjustable limit switches are also provided. In addition to the feed controls, there are rapid transverse movements which can be set from a scale fitted to the hand wheel. The safety couplings attached to all the traversing movements with the further interlocking devices, safeguard the machine from accidental damage, which might be caused by the simultaneous application of opposite feeds. All the gears are enclosed and are lubricated from the forced feed system, and no other attention to lubri-

cators is called for. The upright and bed are diagonally braced, and, as in most modern machines, all the guide ways are chill cast, thereby giving a close-grained, hard-wearing surface, which takes a high finish.

The increasing use of large milling cutter heads, fitted with inserted teeth on machines such as we have referred to, has presented new problems in cutter grinding, which have been solved by the makers by the introduction of new types of automatic cutter head grinders. A machine of this type is illustrated in Fig. 7. It will be seen that separate motors are provided for the grinding wheel, and the main drive. As provision has been made for both wet and dry grinding, special care has been taken to protect all the sliding surfaces and the operating switches. The grinding wheel, with its motor unit, is mounted on a vertical pillar, while the spindle head can be swivelled. These combined movements, which

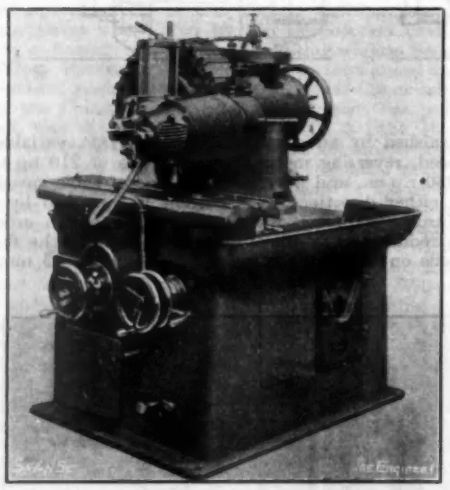


FIG. 7—MILLING CUTTER GRINDER—COLLET

are easily controlled by the hand wheels seen to the left of our engraving, are designed to enable a variety of operations to be carried out. These operations embrace the grinding of cutter heads, spiral fluted cutters, and involute gear cutters, and of the clearance faces on cutter heads with inserted tools.

(To be continued.)

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

OIL-ENGINED LOCOMOTIVES *VERSUS* STEAM.

SIR,—I have read with much interest the Leader in your February 19th issue headed "Railway Critics," and am entirely in agreement with you with regard to ill-informed criticism of the railways.

I would, however, like to comment upon certain criticisms that you yourself have made in regard to claims put forward on behalf of oil-engined locomotives. Being neither an internal combustion engineer nor a representative of an oil company, but representing a firm of locomotive engineers as equally able and anxious to build steam locomotives as oil-engined locomotives, I can claim by your own reasoning to be unbiased.

While I have perhaps been responsible for a good deal of discussion as to the possibilities of the oil-engined locomotive on the British railways, I think I can claim that my contribution has been at least constructive.

As you say, every railway in the land is now watching the oil-engined locomotive with interest, and not one of them is indifferent to it. It is rather a pity, therefore, that you should have thought fit to include in your Leader criticism, which, upon further consideration you may agree, is misleading. You have referred to a statement made by Sir John Cadman that if the British railways turn to oil their present work, which consumes 13 million tons of coal per year, could be done on about 1½ million tons of oil, and you go on to show that this comparison cannot be seriously advanced on the score that it does not agree with the known thermal efficiency of the respective engines in terms of work done at the draw bar per pound of fuel.

The reason that your attempt to reconcile Sir John Cadman's figures with the thermal efficiency of the respective engines has been unsuccessful is that you have omitted to take into consideration losses which do not appear when directly comparing draw-bar tests of two locomotives under similar conditions. You have neglected to take into account the fact that the consumption of 1½ million tons of oil would be obtained by 30 per cent. fewer locomotives than are at present used, and that this smaller number of oil-engined locomotives would not consume any fuel when standing, and, further, that each oil-engined locomotive is capable of making a greater annual mileage, and therefore it has a lower proportion of non-revenue-earning mileage than is at present the case with steam locomotives.

Taking all these factors into account, you will see that it is quite incorrect to attempt to base a comparison of fuel consumption for a whole system on the comparison of fuel consumptions over a test run by two locomotives of the respective types considered.

You will no doubt reply that the number of locomotives of any type that can be used depends upon the traffic available, and with this I agree, and the only way to find what reduction in the present number of locomotives used is possible by the use of oil-engined locomotives, is to sit down and consider each system in detail. This was done by the railway companies—the L.N.E.R. and L.M.S.R.—who provided the data required by the Weir Committee on Electrification of the Main Lines.

This Committee, in conjunction with the railway companies, found that by speeding up goods and stopping passenger services, but maintaining the present speeds for express trains, the number of electric tractors required would be roughly 30 per cent. fewer than the present number of steam locomotives employed. They further estimated in conjunction with the railway companies mentioned the quantity of electric power required per annum for these speeded-up services.

Now, if for oil-engined locomotives you consider the only type which may be at present considered as being out of the experimental stage—that is, the oil-electric locomotive—you will agree that the oil-electric locomotive is in effect an electric locomotive carrying its own power-house. Therefore, after making due allowance for power lost in the sub-stations, transmission cables, and track conductors, and also in rheostatic control of the motors, in the case of ordinary electric traction, and then making an adjustment in the opposite direction for the somewhat greater weight of the oil-electric locomotive, we are able to convert the figure of electric power given by the Weir Committee into a figure of electric power required to be generated on the train by the oil-electric generating set.

This can then readily be converted into tons of oil consumed by the engines, and the result is the figure given by Sir John Cadman of 1·6 million tons of oil per annum, and here I would like to point out that this figure being based upon the electrical consumption given in the Weir report, is for speeded-up services, and is therefore greater than would be required by the British railways to do their present work.

Again, you may suggest that these figures are over-sanguine claims of the advocates of a system of traction other than steam; but here I reply that you must admit that the figures published by the Weir report were based upon investigations made by the two railway companies mentioned, and therefore, so far as traffic conditions and fuel consumption are concerned, cannot be regarded as figures given by advocates of any particular system.

Another point on which I join issue with you is your comparison of the cost of an oil-engined locomotive with a steam engine of similar power. Your comparison of one locomotive with one locomotive is only true where traffic conditions are such that the same number of oil-engined locomotives is required to replace a given number of steam locomotives. If traffic conditions allow the oil-engined locomotives to run the greater annual mileage of which they are capable, then it is obvious that the capital comparison of the locomotives necessary to handle a given system or service will be considerably more favourable to the oil engine than the comparison indicated by the cost of individual locomotives.

We have found that the oil-electric locomotive is on the average capable of making as good a mileage per annum as can be obtained from electric locomotives, and therefore the number of oil-engined locomotives required should be practically the same as that of electric locomotives, *i.e.*, to quote the Weir Committee's estimate, roughly 30 per cent. fewer than the present number of steam locomotives.

In any case, if it can be shown that the net results over the year's working justify the greater initial capital cost of the oil-engined locomotive, then the railway companies are justified in making the change, in just the same way as a chief mechanical engineer is justified in buying an expensive automatic machine tool for his workshops, because it gives him a better economic result than an ordinary lathe, which may cost only a fraction of the cost of the automatic.

As you have yourself pointed out, a mere reduction of the fuel bill in itself is not sufficient, even though based upon a ratio of—in price—4 to 1 between coal and oil, the saving amounts to £6,000,000 per annum, after allowing for the heavy lubricating oil consumption of the oil engine. Factors of even greater importance are locomotive wages and repairs. Locomotive wages will obviously be reduced on account of the smaller number of units in operation, and reduction of unproductive mileage, but they will be still more reduced by the use of motor coach trains operated by a single man, with "dead man's handle" control for the bulk of the stopping passenger services. Based again upon the figures given in the Weir report, it is estimated that about £10,000,000 per annum could be saved under this heading by oil-electric traction, and this, by the way, does not include dense suburban traction, which, we admit, is more economically handled by ordinary electrification. Based again upon the figures disclosed by the Weir Committee, in conjunction with the railway companies, we estimate that a considerable saving, amounting to perhaps £3,000,000 to £4,000,000 could be made under the heading of maintenance.

Here you will at once claim that the repairs and maintenance of an oil-electric locomotive could not be less than those of the very simple steam locomotive, but again you must take into account the fact that there are 30 per cent. fewer units to repair, that a very large proportion of the present running sheds as now used would be eliminated, and that the operations associated with the washing and fire-box maintenance of the boiler, which forms so large a proportion of shed work, will be altogether eliminated. So far as heavy repairs are concerned, which take place at the main repair shops, it is probable that there will be very little difference in cost, but the savings, both in *personnel*, overheads, buildings, &c., on the local sheds should be self-evident.

Taking all these and other factors into account and basing again upon the figures disclosed in the Weir Report in conjunction with the railway companies concerned, we find that a net saving due to oil-electric working as compared with steam of £22½ million per annum should be obtained, and this with better services than those at present carried out by steam locomotives. Taking the present cost of oil-engined tractors, this represents about 15 per cent. return on the capital expenditure involved plus the revenue value of the faster services. This is not, of course, a fair comparison of one type of locomotive against another, because the oil-engined locomotive is penalised both in capital and in running cost to provide the faster services. A true comparison on the basis of the existing services would show a slight increase in annual savings—say, to about £25 millions per annum—but would have a much greater effect on capital cost. By reason of the lower engine powers required in the tractors, the capital reduction would be such that this saving would represent at least 25 per cent. return on new capital in place of the 15 per cent. mentioned for the faster services.

There is one further point which requires mention in this connection, and that is, as you point out, oil is not at present a national product. There is, however, no technical reason why this should not be so. The present price of imported oil is in the neighbourhood of £3 per ton at port; that is to say, when supplied to a locomotive, its price is about three and a-half times the average cost of coal put on to the locomotive. If home-produced fuel oil received protection to enable it to be sold at four times the cost of coal at the locomotive—that is to say, £4 per ton—the result so far as the railway companies are concerned would be as given above, and a large number of low-temperature carbonisation processes would immediately be able to start profitable production, to the great advantage of the national coal industry, as well as to the general advantage of the community by the abolition of railway smoke, not to mention a good deal of smoke from other sources.

Even were the price of oil used on railways and derived from home sources to rise to £6 per ton, the savings made by oil engine traction would only be reduced by £2½ million—that is, from £22½ million to £20 million. I would suggest, therefore, that the cry against imported oil is one that can readily be remedied, at no great cost, and with greater benefit to the nation and the coal industry than by the continued use of coal in locomotives.

A point of interest is where you have gained your impression that the oil-engined locomotive is at present limited to 300 or 400 H.P. and that it is therefore not a practical proposition for general main line operation. I suggest that you have not taken into account the tremendous progress that has been made in the past two years as the result of the experimental work done during the course of the past ten or fifteen years with small and medium-power units. A correspondent, writing in your columns on January 29th, drew attention to the successful 1200 B.H.P. units constructed by Messrs. Sulzer Bros. and Armstrong, Whitworth and Co., Ltd., which are giving excellent service in the Argentine, and also to the four 1700 B.H.P. which we are building at our Newcastle-on-Tyne works for the same railway, as a result of the success of the 1200 H.P. units. I would also refer to the later 1000 B.H.P. units now being put into service in Denmark and Siam. I do not think you can suggest that either the Argentine, the Danish, or the Siamese railways would have gone in for these large power units had they not been satisfied that they were a practical proposition.

With regard to general main line operation, I quite admit that it would be folly to attempt to introduce oil-engined locomotives for the fast express trains in this country at the present moment. It will be necessary for the railway companies to have at least two or three years' experience in the maintenance and operation of the oil-engined type on the less important trains before they would be able to maintain the locomotives to the degree of reliability at present obtained with steam. Further, it is obvious that a steam locomotive makes so high a mileage in the long main line express runs that it will only be possible to make a case for substitution by the oil engine in Great Britain when the oil engine has become generally adopted for the other services.

These arguments, however, do not apply to goods traffic. For goods traffic the annual mileage made by the steam locomotive is notoriously low and could be greatly improved by the use of oil-engined units, and in this class of service fuel counts as an important item, because of the long stand-by periods which are unavoidable in the nature of the service.

I suggest, therefore, that for main line operation of goods and mineral traffic the oil-engined locomotive is an immediately practical proposition, and one in which great savings can be made. C. J. HYDE TRUTCH.

P.S.—The figure of £12,000 for a 300 B.H.P. locomotive, mentioned by your correspondent in the January 29th issue, is several thousands higher than the figure at which we can supply such a locomotive.

London, March 1st.

NATIONAL CERTIFICATES AND DIPLOMAS.

SIR,—The leading article in your last issue, entitled "Technical Education in England, Scotland, and Ireland," contains an interesting analysis of the published results over the past few years of the schemes for the award of

National Certificates and Diplomas in Mechanical Engineering conducted by the Institution of Mechanical Engineers in conjunction with the Board of Education, the Scottish Education Department, and the Ministry of Education, Northern Ireland; I feel, however, that the deductions which have been drawn are not altogether correct.

In the first instance the statement that the awards to successful candidates are in ascending order of merit is liable to misconception. The awards are of two distinct kinds and are not comparable. The certificates are awarded on the results of part-time courses, to students who are normally employed as apprentices or hold other positions in engineering works. The Ordinary Certificate is gained after three years' evening or part-time day work in approved courses and the Higher Certificate after a further two years' work of a more advanced character. A student who gains both these certificates in succession will usually have completed at least five years' steady work in approved classes, and the certificates afford no small tribute to the energy, ability, and determination of those who have been willing, on the top of their day's work in the shops, to forego delights and live laborious "evenings"—may we say ?—in order to equip themselves for the battle of life.

The Diplomas are awarded to not necessarily less industrous, but certainly differently situated students who have followed full-time courses and cannot be regarded as in any way following on the Certificates. The Ordinary and the Higher Diplomas, too, are normally quite distinct; the former is awarded on the results of a two years' course—of which there are comparatively few examples—and the Higher—of more or less Engineering Degree standard—on a three years' course, and the two do not normally follow the one after the other.

The final examinations both for the Higher Certificate and for the Higher Diploma are regarded by the Institution of Mechanical Engineers as equivalent to the standard of the Associate Membership Examination, and it is possible for a student who holds either of these awards to satisfy without much additional work the full requirements of the Institution as regards technical education.

The numbers of awards of various kinds which have been made and the percentages of success in each grade depend, therefore, upon a large number of factors, such as local educational facilities and traditions, as well as industrial conditions and the extent to which engineering employers interest themselves in technical education. Comparisons between results north and south of the Tweed or on opposite sides of the Irish Channel based on all-round averages and without reference to detailed analyses are apt to be fallacious, and I would deprecate any attempt to draw conclusions as to the relative efficiencies of technical education in England, Scotland, and Northern Ireland. Generally speaking, the greatest significance is to be attached in England to the Certificates. The development of courses leading up to these awards during the past ten years has been truly amazing, and no fewer than 126 technical colleges and schools are now conducting approved courses in England and Wales, while in 1931 the awards amounted to 974 Ordinary and 327 Higher Certificates. Diploma schemes have not in England assumed a position of equal importance, and only 20 technical colleges at present conduct such courses, the awards in 1931—for which only 14 colleges entered candidates—amounting only to 40 Ordinary and 37 Higher Diplomas. It may be assumed that the average student in England whose circumstances enable him to take a full-time course aims rather at the acquisition of an Engineering Degree—which can now be obtained at so many universities, or can be gained by external students of London University wherever facilities of study are available—than at the National Diploma. In Scotland the position is different; it is perhaps to some extent a question of "fashion," but it is certainly "the thing" for a number of the best students of institutions like the Royal Technical College, Glasgow, and the Heriot-Watt College, Edinburgh, who are studying for Engineering Degrees to enter also for National Diplomas, and a higher percentage of successes can naturally be expected from such picked material. There is no doubt that similar results would be obtained in England and Wales if it were possible and "fashionable" for the engineering undergraduates of London, Manchester, Birmingham, and other universities to enter for National Diplomas as well as Degrees. Actually, the awards in Scotland in 1931 were 94 Ordinary and 19 Higher Certificates, against 11 Higher Diplomas; so that the relative popularity of the Diploma as compared with the Certificate in Scotland is apparent. No technical college in Scotland conducts an Ordinary Diploma scheme and there is no Diploma scheme at all in Northern Ireland.

I conclude, therefore, that there is no justification for the statement that Scotland is "consistently and decisively in advance of her sister nations" in this respect; each nation has its own needs and traditions, each can learn to some extent from the others, and it is to be hoped that the investigations of technical educationalists in each will be in the direction of the best kind of local development which it has always been one of the fundamental principles of the National Certificate and Diploma schemes to encourage, without any attempt to claim local superiority.

J. E. MONTGOMERY.

March 1st.

SIR,—Your leading article of February 26th on technical education omits to comment on a significant aspect of the figures quoted. On the basis of population, Scotland should have furnished about one-eighth the number of candidates that England did; the actual figure is under one-twentieth. The well-known Scottish zeal for education precludes the assumption that there are proportionally fewer Scots than Englishmen undergoing technical training. The figures appear, therefore, to indicate that drastic selection is exercised in Scotland in order to weed out candidates who are unlikely to pass high in the examinations. If true, this vitiates any deduction drawn from the mere fact that the Scottish candidates secure an undue proportion of the higher diplomas. It would be surprising if they did not; and, in any event, it is more creditable for England to get over half its unselected candidates through than for Scotland to have from 15 to 30 per cent. of failures among its few picked men.

HORACE MYERS, Major.

London, N.W. 3, February 29th.

D.C. TO A.C. CHANGE-OVER PROBLEMS.

SIR,—Your leading article under the above heading reopens an acute controversial issue which has given rise to much discussion and confliction of view. The relative advantages of D.C. and A.C. systems of distribution are so largely governed by particular circumstances that generalisations are usually inconclusive and misleading. Within this category must be placed the sweeping statement which presumably summarises the point of view put forward in your article, that "the obvious course to pursue is to avoid the perpetuation of D.C. distribution wherever possible, and to change over to A.C. whenever financial considerations permit." That financial considerations do not always permit the change to be made is recognised by the same article where it is stated that the converting method of giving a supply is often the simplest and cheapest method, but the inference that D.C. distribution should steadily be abolished demands examination.

It will not be denied that the characteristics of variable-speed control are supplied most efficiently and effectively by D.C. motors, and the D.C. series motor is unrivalled for tractive work of any kind, but in terms of "possibility" these characteristics can be supplied by A.C. motors with much increased complication and lower efficiency. It is very often the case that lower efficiency and the introduction of power factor problems which accompany the change-over of a factory from D.C. to A.C. go far towards offsetting the small losses which would be caused by converting plant. In addition, the installation of converters entails a minimum amount of disturbance to productive activity, and also they have valuable natural properties of power factor correction which can benefit both transmission and generation.

From the point of view of safety, D.C. is less dangerous to life than A.C. at an equal pressure, and it is therefore particularly suited to domestic as well as industrial use.

The conclusion, then, is clear. D.C. has many claims which justify its use as a system for distribution, and the perpetuation, and even the extension, of existing systems may be desirable. Its use is by no means "old-fashioned," as is sometimes implied, and it is neither in the best interests of consumers nor supply authorities that from the fact that A.C. is superior for the purposes of generation and transmission an illogical conclusion should be drawn that A.C. is also superior for distribution.

J. H. R. NIXON, A.M.I.E.E.

Loughborough, February 25th.

[A.C. meets the requirements of the great majority of consumers just as well as D.C., which can always be obtained by local conversion where it is really required. We doubt if many engineers would adopt D.C. distribution if they had to begin to supply electricity now.—ED. THE E.]

ENGLISH STEEL CORPORATION.

SIR,—On page 246 of your issue dated February 26th there is an announcement headed "English Steel Developments," which relates to this company. We desire to say that some of the statements made are not correct. Any manufacture of open-hearth steel productions at the Grimesthorpe works is entirely a temporary matter pending a proposed reconditioning of the Vickers works melting plant. The statement as to transfer of mills and other manufacturing plant from River Don Works and Penistone to Grimesthorpe is also incorrect; no such transfer is contemplated.

For and on behalf of
ENGLISH STEEL CORPORATION, LTD.,
F. PICKWORTH,
Secretary and Special Director.

Sheffield, March 1st.

IMPORT DUTIES ADVISORY COMMITTEE.

IN the House of Commons on Tuesday last, March 1st, Mr. Neville Chamberlain, the Chancellor of the Exchequer, announced the names of the Chairman and members of the Import Duties Advisory Committee, which he said had already held its first meeting that morning at Caxton House. The Chairman is Sir George May, who, it may be recalled, was the Chairman of the Committee on Economy appointed by the Labour Government in 1931, and was, until his retirement, the secretary of the Prudential Assurance Company, Ltd. The two members are Sir Sydney John Chapman, late Chief Economic Adviser to His Majesty's Government, and Sir George Allen Powell, the Chairman of the Food Council and Chief Officer of Public Assistance of the London County Council. The secretary of the Committee is Mr. Percy Ashley, until now the head of the Industries and Manufactures Department of the Board of Trade, who will have under him a small staff of administrative, statistical and clerical officers drawn from the Civil Service.

South African Engineering Notes.

Mining Statistics.

THE Mines Department's statistics for the nine months of the year ended September 30th show a total output value of £37,869,232, compared with £37,820,183 for 1930. Gold accounted for £34,491,801, compared with £34,013,285, and platinum £179,117, compared with £80,196. There was also an increase in "Other Minerals," which totalled £418,300, against £387,611. All other minerals showed decreases: Silver, £46,943, against £63,834; osmiridium, £46,392, against £51,482; coal, £2,333,580, against £2,686,010; copper, £318,834, against £433,223, and tin, £34,265, against £104,542.

Electrical Progress in Durban.

Durban continues to hold the lead as the town consuming the most electricity in the Union and making the greatest yearly advance. For the year ended July 31st, 1931, the total units sold for private lighting and heating was 52,061,334 units, compared with 44,455,774 units for the previous year. Private power called for 22,812,990 units, compared with 24,633,061; Government lighting and power, 9,028,565, against 9,574,295; municipal lighting and power, 2,363,369, compared with 2,178,968; street lighting, 3,375,855, compared with 2,638,768, and tramways, 7,171,633, compared with 7,040,723. Of the total number of units used for private lighting and heating, 39,313,506, or 75 per cent., were "cheap rate" units at 1d., ¾d., and ½d., roughly representing the cooking and heating units, but including a small proportion of lighting units.

New Railway Works.

Very few new railway works are being authorised at present, and every effort is being made to keep expenditure at the lowest possible level. The most important undertaking recently authorised is re-railing 114 miles of track from Amabele to Umtala. Provision of coaling plant is being made at Beaufort West, while on the Richmond Branch points and crossings are being replaced by a heavier type. At Pretoria the electric power distribution system is being reorganised.

Big Road Passenger Service.

A NEW road passenger service has been opened between Nairobi and Johannesburg, the first trip from East Africa to South Africa having been completed on November 18th, when two six-cylinder cars and a truck arrived conveying four passengers.

Big New Crane Arrives.

After a seventy-three-day voyage of 6500 miles the Dutch tug "Ganges" arrived at Cape Town on November 19th, towing a 60-ton floating crane for Table Bay. The tug left Rotterdam on August 31st for Haverton-on-Tees, where the crane was picked up. The voyage out started on September 7th. Owing to bad weather the convoy had to run into Brest for shelter. When the weather moderated a course was shaped for Sierra Leone, which was reached on October 8th. The tug and crane left for Cape Town the same day. Up to that time the tug had averaged about 100 miles per day, but the vessel then met the south-west monsoon with strong winds and made little headway. Head winds were, in fact, experienced almost to Cape Town. The arrival of the crane removes a stigma under which Cape Town has laboured for years, as in future it will not be necessary to send steamers bringing locomotves to Cape Town round to East London for them to be discharged there and go back nearly 1000 miles to Cape Town under steam.

Port Elizabeth Harbour.

The new works at the Port Elizabeth Harbour—or Algoa Bay Harbour—are proceeding steadily. A lot of preliminary work had to be done at the end of the North Jetty so that it could take the weight of the Titan crane which is now being erected thereon. The crane had been in use on the Cape Town dock extensions and had to be dismantled before being taken round by rail. Though it is much smaller than the huge 50-ton Titan crane operating at Cape Town docks extension at present, it is yet a very massive structure weighing when fully assembled about 200 tons and handling 15-ton concrete blocks over a radius of 105ft. When the wall has been constructed out a certain distance from the existing jetty the crane will run off the jetty on to the wall, and follow on as it is built out. The foundations of the quay wall here will be put down by divers from a floating pontoon which will be moored ahead of the wall.

Making the South African Coast Safer.

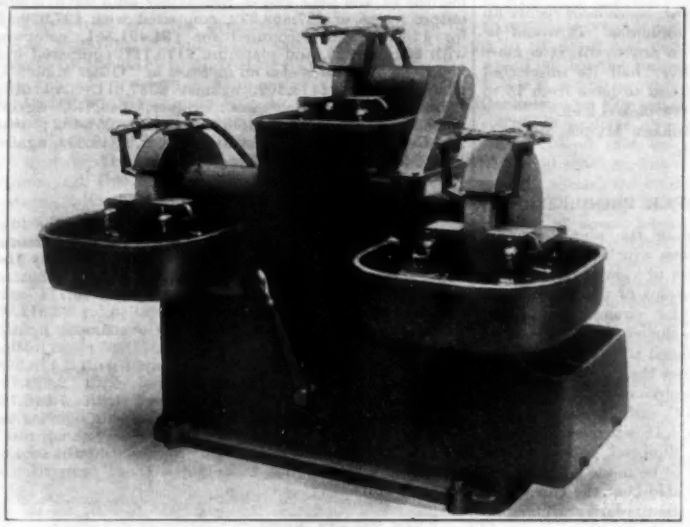
A new electrically operated fog siren will shortly be placed in commission at the extreme end of Table Bay breakwater, where it will replace the bell buoy. The horn will probably be heard at a distance of 2 miles under ordinary conditions, and is for the purpose of directing vessels from Green Point to safe anchorage or to the harbour entrance. The bell has never proved satisfactory, and during thick fogs two tugs are usually placed off the breakwater to assist pilots when bringing ships into the dock.

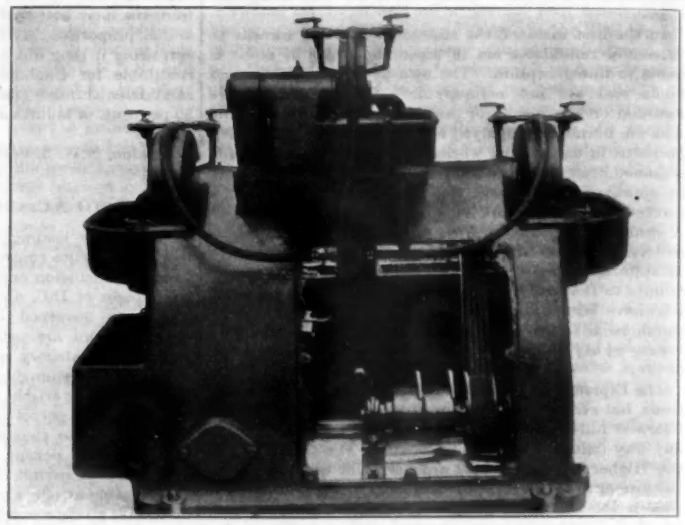
Russian Oil.

Russian oil is steadily gaining ground on the South African markets. The Atlas Oil Company is the representative in the Union and considerable progress is being made in the Cape Town Docks area with the lay-out for three large oil tanks for it. The tanks are being placed in the great quarry excavated out of the solid rock nearly thirty years ago and originally intended to be an additional dock. They will be 72ft., 44ft., and 32ft. in diameter respectively. At a later date it is probable that four more tanks will be erected, the largest having a diameter of 100ft. Provision is also being made for the erection of two more tanks at East London.

GRINDING MACHINE FOR WIDIA TOOLS

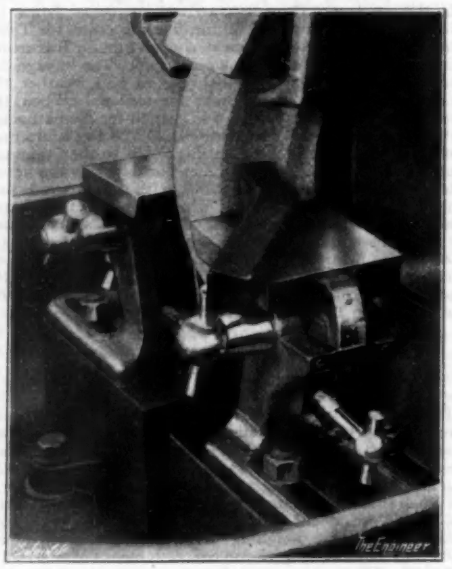
B. R. ROWLAND AND CO., LTD., REDDISH AND A. C. WICKMAN LTD., COVENTRY, ENGINEERS





Grinding Machine for Widia Tools.

We illustrate herewith a machine specially designed for the grinding of Widia tools by B. R. Rowland and Co., Ltd., of Reddish, Stockport, in conjunction with A. C. Wickman, Ltd., of Coventry. The machine is equipped with three grinding wheels, one for roughing, one for finishing, and one for polishing to remove any trace of a saw-tooth edge, as seen under the microscope. The roughing and finishing wheels are 14in. in diameter by 3in. wide, while the polishing wheel is 12in. in diameter by 2in. wide. All three wheels are double recessed, and each has two rests, one on either side. By means of this arrangement any tool, right or left-handed, can be ground on the face of any one of the wheels without reversing the direction of rotation of the wheels and without departing from the



TOOL-RESTS

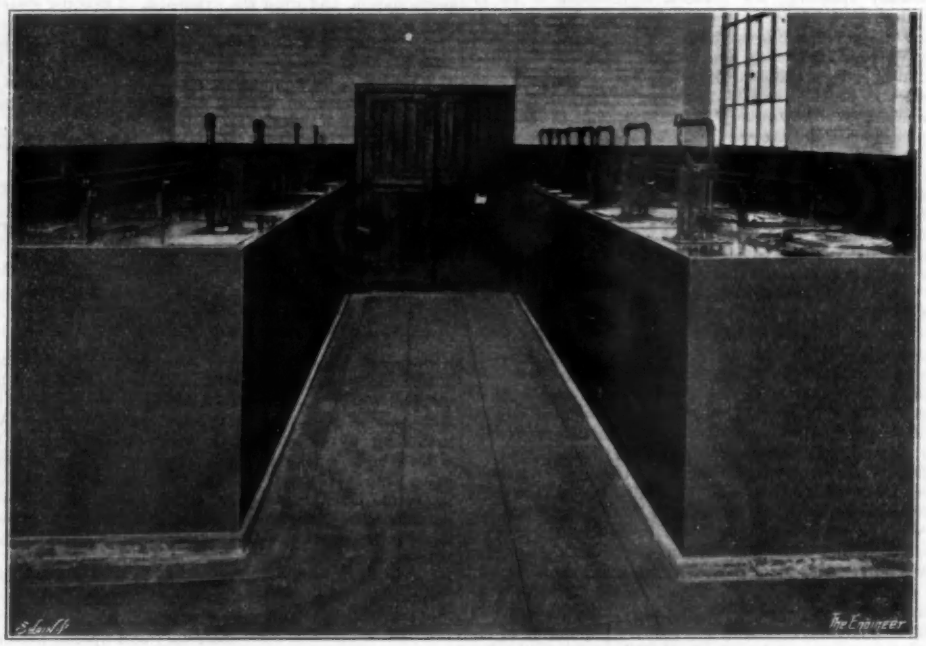
Home Office regulations concerning the guarding of grinding wheels. The tool rests are adjustable for wear on the grinding wheels and, in addition, are adjustable angularly by means of protractor scales marked in degrees. With the aid of the scales, the required angle of clearance on the tool can be set on all three wheels.

The main spindle is 2¾in. in diameter, and is driven by four flexible vee-ropes, either from a motor mounted inside the body of the machine or, as shown in one of our engravings, from a countershaft mounted in a similar position. If a motor is fitted, the control is effected by means of a push-button automatic starter. If the drive is by belt, the belt-shifting gear is operated by means of a handle at the front of the machine. The spindle of the polishing wheel is driven from the main spindle through two flexible vee ropes. Both spindles run on roller bearings, while the endwise thrust is taken on Hoffmann double ball thrust bearings. The housings for the bearings are provided with grease seals of the labyrinth type to prevent the ingress of dirt and grit, and are supplied with lubricant by the Tecalemit high-pressure grease gun system.

The grinding wheels are surrounded by welded steel guards. To each face of each wheel a supply of water, which may amount all told to 180 gallons an hour, is delivered by a nozzle from a belt-driven centrifugal pump arranged within the body of the machine. The nozzles are adjustable, and the water pressure is very low, with the result that while the supply is copious, it is effected substantially without splash or spray. The main water tank is inside the base of the machine and can be cleaned out through a mudhole at the back of the base. In addition, there is an external settling tank, which can be cleaned from the outside without the use of any tool. To remove any difficulty which might be caused by the rusting of the parts, the grinding rests are secured by means of brass nuts, while the protractor scales, the adjusting screws, and the locking bolts of the rests are chromium plated.

Bulk Oil Storage.

In the photograph reproduced below we illustrate an interesting system of bulk oil storage recently designed and supplied by C. C. Wakefield and Co., Ltd., to the Stanton Iron Works, in Nottingham. The system is designed to permit rapid handling without waste, and to ensure that the oil is clean. The installation consists



TANKS FOR THE STORAGE OF OIL IN BULK

of batteries of storage tanks, ranging in capacity from 100 to 300 gallons containing the various grades of oil required. Each tank is fitted with a self-measuring pump for drawing off the necessary supplies. The barrels from which the tanks are filled are hoisted on pulleys to an overhead conveyor, by which means they are transported to the respective tanks requiring oil. They are there emptied cleanly and quickly. The pumps drawing off the oil are similar in design to the majority of petrol pumps, and are so constructed that when the supply of oil has been drawn off a pipe swings into position directly beneath the outlet from the pump and catches the drips, draining them back to the tank. In this way the tanks are kept clean, and there is no loss of oil. The oil in each tank is heated by steam coils and there is a device to protect against the oil becoming too hot.

A factory for producing artificial fertilisers at East Saint John, Quebec, is said to have a capacity of 1000 tons per twenty-four hours.

INSTITUTION OF NAVAL ARCHITECTS.

The annual meetings of the Institution of Naval Architects will be held in the Lecture Hall of the Royal Society of Arts, John-street, Adelphi, W.C. 2, on Wednesday, Thursday, and Friday, March 16th to 18th. The annual dinner of the Institution will be held on Wednesday, March 16th, at 7.30 p.m., in the Grand Hall of the Connaught Rooms.

The following programme of proceedings has been arranged :—

On Wednesday, March 16th, there will be a meeting in the morning at 10.30 a.m., at which, after the transaction of the usual business, the President, Admiral of the Fleet the Right Hon. Lord Wester Wemyss, will deliver his address. The following papers will then be read and discussed :—"Electric Arc Welding in Ship Construction," by Mr. J. Foster King and Dr. James Montgomerie; "A Maier and Normal Form Comparison and Tank Results," by Mr. W. J. Lovett and Mr. E. H. Smith.

On Thursday morning, the meetings will be resumed at 10.30 a.m., when the following papers will be taken :—"Fuel for Merchant Ships," by Mr. John Johnson; "Recent Improvements in the Efficiency of Small Vessels," by Mr. G. A. Brown; "A Method for the Direct Calculation of Flooding Curves," by Mr. A. Letac. At the afternoon session at 2.30 p.m., the following papers will be considered :—"Screw Propellers of Varying Blade Section in Open Water," by Mr. G. S. Baker and Mr. A. W. Riddle; "Cavitation Experiments on a Model Propeller," by Dr. G. Kempf; and "Notes on Two Recent Trial Records," by Mr. W. R. G. Whiting. There will be an evening meeting at 8 o'clock, at which the following papers will be taken :—"The Ventilation of Warships," by Mr. Lloyd Woollard; and "Some Steering Trial Results of H.M. Ships 'Nelson' and 'Rodney,'" by Mr. H. S. Pengelly.

For Friday morning at 10.30 a.m. the following papers have been arranged :—"Notes on the Progress of Motor Shipping to Date," by Mr. A. C. Hardy; "Note on the Presentation of the Mechanical Efficiency in Marine Oil Engines," by Mr. E. Wilding; and "Fuel Consumption

of Steam-driven Auxiliaries in Diesel-engined Tankers, showing the Reduction Obtained by the Use of Exhaust Gases," by Mr. W. H. Dilworth. The afternoon meeting will begin at 2.30 p.m., when Mr. J. H. Lamble will read a paper on "Experimental Investigation upon the Effect of Temperature on the Skin Friction Resistance of a Flat Plate Immersed in a Turbulent Stream."

In order to enable members to obtain a reduction of fare on the railways of England and Scotland and from ports in Ireland, the Railway Clearing House will issue special vouchers enabling return tickets to be obtained at any booking office at a fare and a third, provided not less than 100 applications are received. Applications for vouchers should be made to the secretary, Mr. R. W. Dana.

THE INTERNATIONAL ASSOCIATION FOR BRIDGE AND STRUCTURAL ENGINEERING.

THE first congress of the International Association for Bridge and Structural Engineering will open at Paris on May 18th, when those taking part will meet at a luncheon. On the morning of Thursday, May 19th, the business of the Congress will be begun by a meeting at the Sorbonne, when Professor Dr. A. Rohn, the President of the International Association, will deliver an address on the aims of the Association and the organisation of the Congress. In the afternoon there will be a meeting at which papers dealing with the stability and strength of structural members subjected to compression and bending will be considered. The morning of Friday, May 20th, will be devoted to the consideration of papers on slabs in reinforced concrete structures, and the afternoon to papers on welding in steel structural work. On Saturday morning, May 21st, the papers to be submitted will deal with large girder bridges in reinforced concrete. Saturday afternoon and Sunday will be given over to excursions. On the morning of Monday, May 23rd, papers on the dynamics of bridges will be presented, while during the afternoon the subject to be considered will be the statics of reinforced concrete. On Tuesday, May 24th, the Congress will devote its attention to girders combined with concrete, and to permissible loads on shallow foundations. The concluding day—Wednesday, May 25th—will be occupied by a report of the general secretaries on the conclusions reached at the working meetings, and by a closing address from the President. The aim of the Association is to promote international co-operation among scientists, engineers, and manufacturers, and to further the interchange of knowledge concerning bridge and constructional engineering. To that end it is proposed to hold Congresses at intervals of from three to five years. Membership of the Association may be acquired by anyone interested in bridge and structural engineering, provided he belongs to a recognised scientific or technical society or possesses the requisite scientific or technical knowledge. The general secretaries of the Association—Association Internationale des Ponts et Charpentes—are Dr. L. Karner and Dr. M. Ritter, of l'Ecole Polytechnique fédérale, Zürich.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W. 1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

CAST IRON SPIGOT AND SOCKET DRAIN PIPES.

No. 437—1932. This is the fifth B.S. Specification of a series dealing with Cast Iron Pipes for Water, Gas and Sewage, No. 78; Drainage, No. 437; Low-pressure Heating, No. 40; Flue or Smoke, No. 41; Soil, Waste, Ventilating and Rainwater, No. 416.

The new specification provides for straight pipes only. Drain fittings have not been dealt with in the first issue, but it is hoped that it will be possible to provide for them in a future edition. The pipes are specified in standard lengths of 9ft., exclusive of the depth of socket. The standard weights are inclusive and satisfy the requirements of the London County Council Drainage By-laws.

INDEX TO BRITISH STANDARD SPECIFICATIONS.

The 1932 edition of the Index to British Standard Specifications has just been issued. It is a complete subject index, occupies 40 pages, and shows the wide range of subjects covered by the British Standard Specifications. Copies may be obtained from the Publications Department, British Standards Institution, 28, Victoria-street, London, S.W. 1, price 1s. 2d. post free.

CONTRACTS.

BLACKSTONE AND CO., Ltd., Stamford, inform us that they have recently received contracts from a number of municipal and other authorities at home and abroad for 3in. and 4in. Blackstone "Unchokeable" crude sewage and sludge pumps and pumping sets. The contracts include four pumping sets for Calster sewerage and five sets for Runcorn Rural District Council, and engine-driven portable pumping sets for five different authorities.

THE ASSOCIATION OF CONSULTING ENGINEERS.—This Association held its annual dinner at St. Stephen's Club on Friday, the 26th ult. The chairman of the Committee of the Association, Mr. S. C. Lewis, presided. In proposing the toast "Engineering and the Empire," Mr. David Balfour, M. Inst. C.E., remarked that all works within the Empire of any magnitude had been carried out under the supervision of British engineers, and the secret of their success was thoroughness in conception, design, specification, execution and supervision. Sir Cyril Kirkpatrick, President of the Institution of Civil Engineers, in his reply, congratulated the L.C.C. on its decision to demolish Waterloo Bridge. He much deprecated the fact that nothing had yet been done by the Government in connection with the new Cunarder in view of the standing menace of foreign competition on the Atlantic trade. Sir Edward Crowe also replied. The "Bench and Bar" was proposed by Mr. C. L. Humphreys, and replied to by the Hon. Mr. Justice McCardie and Mr. W. Craig Henderson. Mr. R. W. Hughman proposed the toast of the "Association," to which the chairman responded in fitting terms. A very enjoyable evening was spent.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

General Situation.

THE industrial position in the Midlands and Staffordshire has not undergone much change during the past week. The heavier the trade the duller are the conditions ruling. For many branches of local manufacture this is normally a quiet period, but, even so, business is not up to expectations. Constructional and general engineering remain subdued. In other branches of industry firms working to full capacity are the exception, the great majority being employed at somewhere in the region of 50 per cent. The Staffordshire ironfoundries are moderately engaged, press workers have a fair amount of work, stampers are not too badly off, and the heavy edge tool trade is making progress slowly. The automobile manufacturers are doing a little better, but orders are unequally distributed and the future of one Wolverhampton firm is uncertain, a receiver having been appointed. Considerable activity is met with in the electrical trades, and demand for the products of the local hardware and hollow-ware trades is going up. There is no new movement in the iron and steel market, but it is anticipated that demand will receive some stimulus as a result of the orders taken at the British Industries Fair. The attendance on 'Change in Birmingham this week was reasonably good and a solid tone was maintained. Little new business appears to have been transacted, but pressure in some quarters for larger specifications against existing contracts met with a better response. Generally speaking, consuming works have very little stocks on the premises.

Pig Iron Prices.

Selling prices of Midland brands of pig iron are to remain unchanged for the present. The Central Pig Iron Producers' Association at its usual monthly meeting decided to make no change in the basis of minimum selling prices which have been in existence for some months past. Since the previous meeting of the Association demand has fallen away and any advance in price would probably further depress the market. On the other hand, production costs, having regard to present turnover, are too high to allow of any price concession. Moreover, demand could hardly be expected to react to a lowering of prices. The engineering foundries continue poorly employed, and consumption by the light castings branch is just now rather low. Orders from this section are likely to improve, however, in the near future. Specifications for Northamptonshire and Derbyshire foundry irons are mostly for small tonnages. Furnacemen have substantial orders on their books to the end of the quarter. The pipe foundries still consume the bulk of the Derbyshire output, and smelters' stocks are not unwieldy. In Northamptonshire stocks are larger, but they are being kept down to some extent by sales being made in northern markets at prices below those ruling in the Midland zone. It is unlikely that selling prices will undergo any change before the end of the quarter, when the Association ordinarily meet again. The present minimum selling rates for delivery at stations in the Black Country are: Northamptonshire forge, £2 17s. 6d.; No. 1 foundry, £3 5s. 6d.; No. 2, £3 4s. 6d.; No. 3, £3 2s. 6d.; No. 4, £3 1s. 6d.; Derbyshire forge, £3 1s.; No. 1 foundry, £3 9s.; No. 2, £3 8s.; No. 3, £3 6s.; No. 4, £3 5s., all subject to rebate to large users.

Manufactured Iron.

Dullness persists in the Staffordshire finished iron trade, demand being confined to small parcels, chiefly of best grade iron. Although there are only a few mills at work, it is a constant source of anxiety to makers to keep plant operating from week to week. Ironmasters cannot look ahead with confidence, inquiries failing to furnish any evidence of an expectancy of improved demand in the consuming trades. It has been a long while since trade was so flat, and the outlook so obscure as it is at present. When engineers have work there is always a certain call for high-grade Staffordshire bars, which cannot be excelled for exacting engineering requirements. Progress in engineering would soon be felt by Staffordshire ironmasters. Crown quality iron has been in poor request for over a year, and sales are few and far between. Nut and bolt works in the Black Country are better employed than they were, but this is not reflected in the demand for Staffordshire bars, most of the material being made up being of Continental origin. District makers are right off the market in competition with Belgian houses. Wrought iron tube strip is in regular call, but tonnages are smaller. Selling prices of finished iron show no change. Marked bars are £12 per ton at makers' works, Crown bars £9 5s. to £10, nut and bolt and fencing bars £8 7s. 6d., and iron strip £10 10s. to £10 12s. 6d. per ton delivered.

Steel.

The position as regards steel is unaltered. Demand alike for finished and semi-finished material shows no expansion and the tendency on the part of consumers to postpone the placing of business has become more marked. There is very little work of any importance in Midland constructional engineers' yards, consequently, specifications for finished steel are poor. Makers of rolling stock are by no means fully occupied, though staffs have been reduced and improvement in the general heavy engineering industry has still to come. The Association level of prices is upheld, angles being £8 7s. 6d., less 15s. rebate to users of British steel only; tees, £9 7s. 6d., less 15s.; joists, £8 15s., less 22s. 6d., and ship, bridge and tank plates, £8 17s. 6d., less 15s. Boiler plates continue to sell at £8 12s. 6d. The half-products department has not been affected by the new duty. Consumers are heavily stocked with Continental material and have no immediate need to place further orders. At date the market for foreign steel is stagnant. British quotations are unchanged, small bars re-rolled being £6 10s. to £6 12s. 6d., all-British bars £7 5s. upwards, mild steel billets £5 7s. 6d., and sheet bars £5 5s.

Tin-plate Control.

The revival of the tin-plate pool has had no effect upon the Midland market. Forewarned, buyers had placed substantial orders at something like 14s. 6d. per box, and they have no need to buy now at the new agreed minimum of 16s.

Galvanised Sheets.

The minimum selling figure for galvanised corrugated sheets of 24-gauge is maintained at £9 10s., with some firms asking anything up to 5s. more per ton. Local mills are better supplied with orders, and fresh inquiries are coming along from overseas. Demand from the home market continues reasonably good. Orders for black sheets are not up to normal for March.

The Trade Fair.

Industrialists from the Midlands and Staffordshire exhibiting in the Birmingham section of the British Industries Fair express satisfaction with the first week's results, and reports so far this week promise further progress to the end of the Exhibition. Some really good business has definitely been placed; some goods have been ordered as samples and inquiries have been legion. These remarks apply equally to the heavy and light sections of Midland industry, and it is considered that the Fair will pull some weight in the trade improvement which it is believed has now commenced.

The Chain Trade.

In view of the severe depression existing in the shipbuilding and engineering industries, no one could be surprised at the present conditions in the chain trade, said Mr. C. H. Sitch, general secretary of the South Staffordshire Chainmakers' and Strikers' Association, in his annual report presented this week. After alluding to the fact that the chain trade largely depended for its prosperity upon the shipbuilding and engineering industries, he pointed out that in 1913 Britain built 1,956,606 tons of shipping, while the rest of the world built 1,374,537 tons, while last year Britain only built 400,505 tons and the rest of the world 1,003,290 tons. The total being built at the end of December last represented only about 20 per cent. of the tonnage being built in 1913, which was the lowest figure recorded since September, 1887. Further, out of the 400,500 tons, work had been suspended on no less than 154,000 tons. Mr. Sitch attributed the very serious decline in the export of chains chiefly to the fact that countries which formerly bought from Britain were manufacturing for themselves. In 1929 we exported 15,594 tons of chains and anchors; in 1930, 13,739 tons, and last year only 7543 tons. The pre-war export figures averaged more than 2000 tons a month. The report alluded to the fact that there had been a considerable development in the application of machinery to the chain trade during the year, so far as the smaller sizes of chain were concerned. Mr. Sitch doubted whether electrically welded chains were better than hand-made, and expressed the view that contracts for the former had been placed by the Admiralty because of cheapness. The report, on the whole, did not take an optimistic view of the future prospects of the chain and anchor trades.

Wagon Company's Strong Position.

The seventy-eighth annual report and balance sheet of the Birmingham Railway Carriage and Wagon Company, Ltd., discloses that the company is in a strong position. After passing through what the report describes as "a year of altogether unprecedented difficulty and depression," the directors are able to recommend a dividend of 5 per cent. Last year it was 10 per cent., but the report furnishes proof that the year's work has been by no means valueless. During the year over £10,000 has been spent in additions to buildings, plant, &c. The stock in trade and work in progress is valued at £353,589, the bulk of this sum representing rolling stock, much of which is in an advanced stage of construction.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Engineering Trades' Difficulties.

ENGINEERING trade conditions, with particular reference to Lancashire, were discussed by Mr. Louis E. Mather, at the annual meeting of Mather and Platt, Ltd., Park Works, Newton Heath, Manchester. Mr. Mather emphasised that in company with the vast majority of engineering concerns in the country during 1931, such an all-round scarcity of business had never been experienced since before the war. Even with Russia, which has had large orders to place, the length of credit required has made business very difficult. On this point, Mr. Mather stated that few countries, if any, were now able to extend such favourable terms of credit as they had done in the past few years, and the sooner the Russian Government realised that fact the better for all those concerned. There are hopes of favourable marketing opportunities for engineers, especially in the electrical branch, in the Argentine, but that country, like most others, has suffered severely during the past twelve months, and the anticipated development has not yet matured. A hopeful feature referred to by Mr. Mather was in connection with the Indian market, the political troubles in which country have of late been having a very severe influence on the demand for Lancashire engineering products. The speaker said that instructions had just been received to resume work on orders that had been in abeyance, and he expressed the view that conditions in that country were settling down. Satisfactory progress is being made with the manufacture of canning machinery, and although business so far has been largely in connection with the home market, prospects of developing this branch

with various parts of the Empire are reasonably bright. Beyond stating that, from the point of view of order books, 1932 has opened better than last year, Mr. Mather declined to attempt to predict as to what the year had in store for the engineering industries.

A Bridge Reopened.

After being closed to traffic for about six months for the purposes of repair and reconstruction work, the Trafford-road Bridge, which crosses the Manchester Ship Canal, very close to the Trafford Park industrial area, was reopened towards the end of last week, the work having been completed in rather less than the scheduled time.

Machine Tool Makers' Capital Reduction Proposal.

A scheme for reducing the company's capital is outlined by the directors of Kendall and Gent (1920), Ltd., machine tool makers, of Gorton, Manchester. Pointing out that the capital it is sought to cancel has been lost or is no longer represented by assets, the directors propose to write 13s. 4d. off each of the £1 shares, stating, at the same time, that conditional agreements have been entered into with loan holders whereby loans totalling £36,366 will be reduced proportionately. If and when the reduction of capital has been carried out, it is proposed to restore the authorised capital of £150,000 by a fresh issue of shares.

Merger of Paper-making Engineers.

Two Lancashire firms of paper-making engineers are to merge their interests. An official announcement just made states that an arrangement has been arrived at under which Charles Walmsley and Co., Ltd., of the Atlas Works, Bury, a company which was established in 1866, will acquire a controlling interest in the business of Bentley and Jackson, of the Lodge Bank Works, Bury. The latter concern was established about 1860.

Canal Dock Developments.

Except to report good progress, Mr. Alfred Watkin, who presided at the annual meeting on Monday of the Manchester Ship Canal Company, added little to what has been made known regarding the construction of the wharf and lay-bye at Irlam in connection with the works of the Lancashire Steel Corporation and of the new oil dock at Stanlow, near the entrance to the canal. An interesting statement, however, was that, with a view to economy, the immediate expenditure on the Stanlow scheme is to be reduced to £200,000, as compared with the original estimated cost of £240,000.

Dismantling a Steel Plant.

It was announced early this week that the Siemens steel-making and engineering and armament plants at the Openshaw Works, Manchester, of the English Steel Corporation are to be dismantled, the contract for the work having been placed with Thos. W. Ward, Ltd., Sheffield. The works were originally controlled by Sir W. G. Armstrong, Whitworth and Co., Ltd. The crucible steel and small tools department at the North-street Works will, it is understood, continue in operation.

Non-ferrous Metals.

From the point of view of prices, the non-ferrous metals have passed through a disastrous week, with copper and lead the principal sufferers. Whatever the technical explanations that may be advanced to explain the position—heavy supplies of most of the metals are, of course, a material factor—there is no doubt whatever that the poor demand in almost every section is playing a major part. The fall in copper during the past week has been the most severe for some considerable time, standard brands being about £4 10s. per ton lower on balance, with refined descriptions also lower and in poor request. The statistical position of tin is less depressing than that of copper, and although the prices current at the moment of writing are round £2 per ton below last week's parities, the decline relatively to the value of the metal has been much less pronounced than in any other section of the market. The demand for lead in all centres is quiet, and here also there has been a serious fall in quotations. Inquiry for spelter, especially from the galvanising trade, has continued very slow, and offers of the metal are lower compared with a week ago by about 12s. 6d. per ton.

Iron and Steel.

Business in the iron and steel markets in Lancashire still shows little indication of improving. Foundry iron makers are not complaining so much regards delivery specifications, but new contract bookings in this section are particularly disappointing after the marked spurt witnessed in the early autumn months. There has been no alteration in the price position, Staffordshire, Derbyshire, and North-East Coast No. 3 being quoted at 67s. per ton for delivery to users in the Manchester price zone, Northamptonshire at 65s. 6d., Scottish at about 87s., and West Coast hematite at 81. In the case of bar iron, best Lancashire bars are maintained at £10 5s. per ton and Crown quality at £9 15s., but the demand for all descriptions continues very restricted. There has been no improvement in the condition of the heavy steel-using industries in Lancashire, and the call for structural qualities, as well as for locomotive and boiler plates, is largely restricted to early delivery needs, with bars of all varieties, except perhaps the small bright drawing kind, in small demand. Inquiry for special alloy steels this week has also been on a disappointing scale.

BARROW-IN-FURNESS.

Hematite.

There is little evidence of an improvement in the hematite pig iron trade in this district. There have been rumours to the effect that America might become a customer in view of the low price owing to the exchange rate, but she has as yet shown no signs of needing more iron at present, and until there is a general improvement in the iron and steel trade in the United States the stocks which exist in this district will remain on the heavy side. With a restriction of output, stocks are naturally being reduced, but only slowly. Home buyers are restricting their orders to actual immediate requirements, and these are not heavy. Continental business is thin. As regards iron ore, the requirements for the district are lighter than they have been for a considerable time. The local mines are bringing up small tonnage, and the imports of foreign ore are light. The steel market is very dull, and few orders are available.

SHEFFIELD.

(From our own Correspondent.)

Disappointing Conditions.

ONCE again it must be stated that there is no improvement in the steel trade of the Sheffield district. Many leading manufacturers seem to be reconciling themselves to a continuance of the depression, and this is particularly disappointing, as conditions at the beginning of the year seemed to indicate the prospect of a revival. Of course, there are sections of the industry which are doing fairly well, and some makers of special steels have been experiencing improved trade during the last few weeks. In stampings and forgings also considerable work is being done by certain firms, including the United Steel Companies, Ltd. At this firm's works and also the works of the Parkgate Company, production has been maintained at a substantial level since the beginning of the year. Satisfactory orders continue to be received for cold-rolled steel strip, and stainless steels are in request for an ever-widening field of industrial application, although quantites are generally small. There has been a slight improvement of trade in the Lincolnshire steel-producing area, and production has been increased at Lysaghts' works, where the plant is busier than it has been during the past year.

Portuguese Warships.

There is a prospect of a contract for warships for the Portuguese Navy being placed in this country, and it is hoped that Sheffield will secure some of the work. The contract, which is for an aircraft carrier, two sloops, and two submarines, was originally placed in Italy, but has been cancelled, owing, it is stated, to a dispute in regard to the currency in which payment for the vessels is to be made. It is suggested as probable that the contract will be secured by Vickers, who already have secured orders from Portugal for other vessels. In any case, it is likely that Sheffield will benefit both directly and indirectly through the contract being offered in this country.

Railway Work.

Conditions in the railway materials section of local industry are very depressed, and it is stated that exports of railway stock and materials are less than a quarter of the quantities of former years. Consequently it is of importance to note that orders have been placed by the L.M.S. Railway with the company's workshops at Crewe and Derby for the construction during 1932 of 130 new steam locomotives which, on the average, will be 30 per cent. more powerful than those which they will displace and 24 per cent. cheaper to run. The new orders, which, it is understood, will keep the works employed throughout the year, form a continuance of the L.M.S. policy of standardisation which has enabled the variety of types to be reduced from 393 in 1923 to 261, and which resulted in last year's locomotive expenditure being no less than £3,250,000 below that of 1927. The L.M.S. has also been enabled to reduce its locomotive stock by 12½ per cent. during the past eight years, while during the same time the average power of the engines has increased by 12 per cent. and the number of engines under and awaiting repair at one time has been reduced from 1985 in 1923 to 383.

Foreign Firms' Inquiries.

Since the imposition of tariffs several foreign firms have made inquiries in regard to the establishment of factories at York, and it is stated that negotiations are now proceeding in regard to two proposed factories. One firm requires a site of 40 acres and the other one of 20,000 square feet. Rotherham is also making efforts to attract new works, and had a special stand at the British Industries Fair, Birmingham.

Cutlery and Plate.

There has been no improvement of the depressed state of trade in silver plate, table cutlery and pen and pocket knives, but improved business is being done in scissors and safety razor blades. The Wafer Razor Company, Ltd., Sheffield, has booked an important order for blades for Rumania. This is so large that the firm's plant will have to be increased. The precise details are not disclosed, but the order will take a long period to execute and, in addition, this firm has secured at the British Industries Fair, Olympia, orders from Canada, Holland, and the United States.

South Yorkshire Road.

A new road between Rawmarsh and Swinton, South Yorkshire, has been opened to vehicular traffic. This is a result of a scheme jointly undertaken by the Swinton Urban District Council and the Rawmarsh Urban District Council, the work having been in progress for nearly four years. The new road is to take the place of an old road which was extremely dangerous, dipping steeply and then ending in a narrow and tortuous course. To make the new road level, a deep cutting had to be made at the Rawmarsh entry, and extensive banking had to be built up for the centre portion, with a further cutting at the Swinton end. The roadway is 40ft. wide with a 20ft. footpath on either side, and with a view to further development a bridge has been erected midway along the high banking. This bridge is of reinforced concrete, and rests on thirty-two large pillars. It will permit, if necessary, another thoroughfare being taken under the new road into the surrounding valley.

NORTH OF ENGLAND.

(From our own Correspondent.)

Little Impetus from New Tariff.

CHIEF interest is now being centred in what is likely to happen in the iron and steel industries now that the import duties on foreign material have become effective. So far there have been no direct effects in the North of England, and any impetus which may be derived is expected to develop slowly. At the same time manufacturers in this area are making every effort to induce consumers, who have been taking foreign supplies, to place their orders at home. Many of these consumers, however, have very large stocks of foreign iron and steel, which have been imported in recent months in anticipation of a tariff being imposed, and these will have to be liquidated before they come on to the market. That they will come forward with their business as their stocks dwindle and Continental supplies become restricted, is the prevailing impression. Meanwhile, iron and steel producers in this district are maintaining their prices at recent levels to encourage sales.

Export Trade Recovery.

Statistics of the exports of iron and steel from the Cleveland district during February reveal a welcome recovery, about 7000 tons more material being shipped than in the preceding month. Scotland has resorted to other sources for her supply of pig iron, and took only 2411 tons of Cleveland last month; but, in spite of the contraction in the Scottish trade, coastwise shipments of pig iron totalling 5381 tons represent an advance of 890 tons, and foreign shipments increased by 1142 tons, Italy being the best customer with 1474 tons to her credit. Manufactured iron and steel shipments advanced from 21,857 tons in January, to 26,920 tons in February, the increase being exclusively confined to the foreign trade. Especially interesting is the fact that two cargoes of steel, amounting to 2662 tons, have been shipped to Russia. The Union of South Africa took 2093 tons, India 1764 tons, Canada 1593 tons, Argentine 1566 tons, Portuguese East Africa 1276 tons, and Japan 1128 tons.

Cleveland Iron Trade.

There is an absence of feature of moment in the Cleveland pig iron trade. Consumption is still on a very limited scale, and Cleveland iron is losing ground in Scotland, where competition by Midlands and Indian iron is very keen. Small parcels of Cleveland iron are being sold for this month's delivery, but consumers are not inclined to negotiate forward contracts. Makers, however, are in quite a strong statistical position, and are determined to continue so by regulating, as far as possible, output to requirements. They are carrying little, if any, more stocks than are desirable for ordinary trading, and the needs of the near future promise to further reduce the accumulations at the blast-furnaces. Prices are steady and firm, No. 1 Cleveland foundry iron being 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

Hematite Pig Iron.

Producers of East Coast hematite pig iron complain that contracts made at prices obtainable entail actual loss, and they hesitate to sell at all heavily at ruling rates. Merchants, however, have still substantial quantities, with the result that buyers experience no difficulty in satisfying their requirements on the basis of 63s. 6d. for mixed numbers. Even that price can be shaded for suitable business.

Ironmaking Materials.

The foreign ore trade is idle, works being overstocked, and 16s. 6d. c.i.f. Tees is a purely nominal figure for best Rubio. Blast-furnace coke ranges in price from 16s. 6d. to 17s., delivered at the works.

Manufactured Iron and Steel.

As the spring approaches, hopes of a better demand for finished iron and steel grow stronger. But the market is still lethargic, and some departments are badly in need of orders. Makers are not sanguine about the effects of a 10 per cent. import duty, which they declare to be inadequate, but there appears to be a little more life in the export trade. Producers of constructional steel are fairly well employed, and more railway material is being turned out than of late, but those engaged on shipbuilding requisites are still very short of orders. Prices are unaltered.

The Coal Trade.

There is no perceptible improvement in the state of the Northern coal trade. Conditions, in fact, are becoming increasingly difficult. A number of pits are idle, and some collieries report a very dull condition of things. Orders are scarce and the further curtailment of German imports as from March 1st has led to the cancellation of some cargoes and the postponement of others. Large quantities of gas coal have been supplied from this area to German cities, and bunkers to the coastal ports. In addition, since the devaluation of sterling, Northumberland and Durham coal has penetrated more into the interior, while conditions in the Ruhr coalfield have got steadily worse for months past. It is to help the German mines that the import restrictions have been increased, and this decision is sure to react adversely on the North-East Coast. The Northumberland collieries have a fairly full loading list over the next few days, but there is not much doing ahead. They have a satisfactory coast trade, but this may fall away with the approach of spring. Northumberland will feel the effect of the German limitations nearly as much as the sister county of Durham, and where new markets are to be found it is difficult to say, although hopes are growing of more business being ultimately secured from Canada. The outlook in the steam coal section is disappointing. New business is difficult to obtain, and demand under contract commit-

ments is being steadily reduced. Tonnage is scarce and, combined with the high rates asked by owners, merchants are prevented from stemming freely against contract bookings. Every quality is thus abundant and offered at the recent minimum values. Large steams are at 13s. 6d., second qualities 12s. to 12s. 6d., and smalls 8s. 6d. Tyne primes could do with more trade and a quicker taking out of commitments by contractors, though the latter do not find it easy to get customers. The demand for bunker coal is steadily maintained, supplies being moderately plentiful; but owners hold firmly. Best or special classes are worth 13s. 9d. to 14s. Secondary grades, however, remain easy at 13s. Production is having to be further curtailed in the Durham gas coal trade. Prices are easy, best qualities being 14s. 6d., and seconds 13s. 3d. to 13s. 6d. Coking unscreened is neglected and unchanged at 13s. to 13s. 9d., with coking small at 12s. 6d. to 13s. 3d. There is little movement in the coke section. Stocks abroad are being reduced as a result of the colder weather, but they are large at most places, and there is not likely to be much more buying for the remainder of this winter. Gas coke is readily obtainable at 19s. Patent oven coke is in ample supply at 16s. to 16s. 6d., and superior makes at 18s. to 20s. Coke nuts are in moderate request, but quoted steady at 19s. to 20s., as makers restrict production to actual requirements.

Coal Trade Wages.

A further setback to the Northumberland coal trade during the month of January is indicated by the figures produced at the ascertainment of the state of trade by the joint accountants. The available surplus amounted to 18·71 per cent. on the basis, as compared with 21·94 per cent. for the preceding month. As the minimum percentage for the county is 40 above the basis, the owners are required to make up the deficiency of 21·29 per cent. The Durham coal trade also showed a falling off. The proceeds and costs will allow of miners' wages this month being 35·39 per cent. on the basis, compared with 41·43 per cent. in February, a reduction of 6·04 per cent. The minimum is 65 per cent., and thus the deficiency to be made up is 29·61 per cent.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

THE latest returns from the Clyde shipyards only serve to emphasise the state of depression existing in the industry. During the month of February, only one vessel, of 5350 tons, was launched on the Clyde, compared with five vessels, of 15,075 tons aggregate, in February of last year, and twelve vessels, of 47,184 tons aggregate, in February, 1930. Since the beginning of this year, apart from barges and small craft, only one order has been placed on the Clyde, that being the contract placed with Messrs. Denny, Dumbarton, for a 2000-ton railway steamer. The total output from Clyde yards for January and February only amounts to three vessels, of 7238 tons aggregate. The February launch was the passenger and fruit-carrying steamer "Jamaica Progress," 5350 tons, built by Messrs. Lithgows, Port-Glasgow, for the Jamaica Banana Producers' Association, Ltd., Kingston, Jamaica. At the present time the berths almost all up and down the Clyde are empty, and the same may be said of the fitting-out basins.

Steel.

In the Scottish steel industry business is, if anything, quieter, and producers have difficulty in maintaining even a moderate rate of output. Shipbuilding requirements are, of course, very restricted, and the turnover in structural material has been considerably below normal. Steel makers are not so busy as they were a week or two ago, and the flow of orders has lessened, probably in a measure owing to the higher prices consequent on a rise in the costs of raw materials. Galvanised sheets, too, are quieter.

Iron.

The demand for bar iron continues on a most subdued scale, the last price reduction having failed to produce any improvement. Re-rolled steel bars have been subjected to considerable price cutting in recent weeks in an endeavour to secure a better proportion of the business offering. The result has not been very satisfactory, however, and the outlook has not been improved by the rise in costs of production. Meanwhile, prices remain round about £6 5s. home and £6 2s. 6d. per ton export. Scrap is comparatively dull, with prices unchanged at 52s. 6d. to 55s. for cast iron machinery, and 40s. to 42s. 6d. per ton for heavy steel.

Pig Iron.

The only fresh feature in the pig iron trade was the opening of a new and modern furnace by the Shotts Iron Company. Outputs are still more than sufficient to cover requirements. During the past week 500 tons of pig iron arrived in this district from Barrow, while shipments from the Clyde amounted to 623 tons (600 tons foreign), compared with 464 tons (314 tons foreign) in the same week last year.

Coal.

The demand for Scottish fuel is not improving, either for home or export account. The stocks held abroad may perhaps retard business as much as the restriction of imports, but, at any rate, business meantime is confined to small quantities for immediate shipment. Forward bookings are almost unknown as the colliery quotations are unfavourable, and exporters are not disposed to take any undue risks at present. All round fuels, with the possible exception of Lanarkshire prime splints, are easily obtainable at current prices. Washed treble and double nuts are not so plentiful, and are inclined to firm, but smaller sizes are easy. Aggregate shipments amounted to 224,251 tons, against 262,492 tons in the preceding week, and 204,647 tons in the same week last year. The Swedish State Railways are asking for tenders for 108,000 tons of locomotive coal for April–June; also 5000 tons of bunkers.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

THE conditions in the steam coal section of the industry of this district have been rather disappointing, as new business has been very slow to mature, and, unfortunately for some collieries, tonnage has not been available to suit some of the orders which are held. All last week the position of collieries was by no means satisfactory, as will be seen from the fact that the number of vacant loading berths averaged daily round about thirty, and on the last day of the week rose to as many as forty-two. On Monday the number was reduced to twenty-nine, which did not enable many collieries to make a very good start. The severe gale which raged over the week-end was responsible for many steamers not being able to make port, and even on Tuesday vessels which should have put in an appearance earlier had not been able to dock and were reported to be still sheltering round the coast. There may possibly be a certain amount of loading pressure later if steamers come up together, but it can only be of a temporary character, and meanwhile, collieries are compelled to work very irregularly. Shipments last week, according to the G.W.R. Company's figures, were disappointing, as the total was only 374,450 tons, which compared with 394,410 tons for the preceding week and with 419,434 tons for the corresponding period of last year. Hopes are entertained that the removal of the French surtax of 15 per cent. will, before long, have a beneficial effect upon shipments from this area to France, but most of the big shippers have a fair idea what they will be able to do this month, and so far there is not a marked improvement upon their requirements. It is, however, possible, that later on fresh inquiries will be received which will lead to business. In other directions there is no material expansion in operations. Although the Danish State Railways are reported to have covered their requirements, it is understood that only a very small quantity is being placed for Welsh coals, probably about 18,000 tons. A certain amount of business is being negotiated for Portugal for delivery the end of this year, and the greater part of 1933, and is expected to come to this district, while the Bristol Corporation has asked for tenders by the 16th inst. for 77,000 tons of washed and unwashed steam small coals for delivery at the Portishead electricity station over six or twelve months from April 1st. The news from Germany is not at all satisfactory, as the Reich Coal Board has decided further to curtail imports of British coal into Germany. As from the beginning of this month imports are to be cut down by 50,000 tons, and from April 1st there is to be an additional reduction of 50,000 tons. As reductions had been made previously the cumulative effect is considerable, as it will mean that as from the beginning of next month the quantity of British coal which may be imported will be at the rate of about 1¼ million tons per annum, whereas for last year the quantity exported from this country to Germany was nearly 3¼ million tons, and in 1929 over 5 million tons. It is true that the bulk of the British coals going to Germany has been drawn from the North-East Coast, but less business for the Northern coalfields reflects upon all the other coal-exporting districts eventually.

Coalfield Audit.

The ascertainment for the three months November, December and January for the South Wales coalfield has been received from the joint accountants, and whereas, for the preceding quarter there was a loss of 1¼d. per ton on all coal disposed of commercially, this has been changed into a profit of 0·69d. per ton. The percentage payable on the 1915 standard came to 2 per cent., but as the miners are entitled under the agreement to 20 per cent., the result is that there will be no change in the wage rate for the ensuing quarter. The actual output was 8,978,864 tons, as against 9,085,413 tons in the previous three months. The proceeds at the pithead were 13s. 8·56d. compared with 13s. 8·04d. per ton, and the man shifts worked 8,918,351, compared with 9,043,959. The wages paid per shift were 8s. 10·7d., compared with 8s. 11·5d., while the costs of production other than wages, were 4s. 9·87d., as against 4s. 10·54d. On balance there was a profit of £25,000, as compared with a loss of £57,000 the previous quarter. After the payment of the minimum of 20 per cent., the deficiency is shown to be £674,000, which, with the previous deficiencies, makes a total of £2,884,783. According to Mr. O. Harris, the new secretary of the South Wales Miners' Federation, there will have to be an increase of 3s. 11d. per ton in the price of coal to enable the miners to earn a living comparable with the pre-war time of 1914 and the coalowners to make a profit.

Tin-plate Pool.

At a meeting of the Welsh tin-plate trade last week it was decided to re-establish the tin-plate pool, which, some months ago, was abandoned, the object being to adjust production to the demand. It is, of course, dependent upon a 100 per cent. representation without which such a scheme was regarded as impossible of achievement. Points of the scheme provide that no works shall operate to more than 75 per cent. of capacity until the demand generally is above that percentage of trade capacity. An assessor will decide the capacity of each individual works, and output will be restricted by a quantum allotment percentage. If a works exceeds the allotted percentage, it will pay 1s. per box on the excess into the pool in the first quarter and 2s. per box in the second and subsequent quarters. Works which produce under their allotted percentage will draw out 1s. per box in the first quarter and 2s. per box in subsequent quarters. Works will continue to book their own orders as previously, but the minimum selling price was fixed at 16s. per basis box to operate immediately for an indefinite period.

Development of Industry.

It was decided at a representative gathering at Cardiff on Friday last to approve the appointment of a committee to consider the desirability of establishing a regional development council for the industrial area of South Wales and Monmouthshire, and Sir Horace Wilson, Chief Industrial Adviser to the Board of Trade, was invited to formulate the terms of reference to the various matters it is desirable the committee should consider with a view to their proposals and recommendations being submitted to a further conference. For the time being Swansea is not taking part in the movement, pending its representative's report on the conference. Since then, the Lord Mayor of Cardiff, in consultation with Sir Horace Wilson, has chosen a committee of six to prepare a draft constitution and aims and objects for the proposed council.

South Wales Miners.

The executive council of the South Wales Miners' Federation at Cardiff on Saturday unanimously accepted the ballot for the election of Mr. Oliver Harris as general secretary, and agreed that he should commence his duties officially as from March 1st. It was also decided that the question of reorganisation of the Federation should be taken in hand immediately, and a committee was appointed to report at an early date.

Docks Traffic.

The G.W.R. Company's returns of traffic at the six ports in this area under their control show that for the four weeks ended February 14th, imports and exports came to 2,122,361 tons, made up of imports 326,726 tons, and exports 1,795,635 tons, which compares with an aggregate for the preceding month of 1,970,194 tons, comprising imports 253,447 tons, and exports 1,716,747 tons.

Current Business.

There has practically been no development so far as coal operations for prompt loading are concerned, and prices in all departments are unchanged. The feature of the market concerns freights. Orders are held for large sized tonnage for the Mediterranean, but very little is offering for employment in this direction. A fair amount of tonnage has recently been attracted to the river Plate, and the position is that there is a scarcity of prompt tonnage offering for Mediterranean destinations. The consequence is that rates of freight for Genoa have risen to 7s., whereas a month ago the rate was 5s. 10½d. to 6s. Small tonnage, however, is offered more freely. Coke is a steady market and patent fuel remains without material alteration, but pitwood is weaker at 20s. 3d. to 22s. 6d.

ENGINEERING GOLFING SOCIETY.—The twenty-third annual general meeting of the Engineering Golfing Society was held, by permission of the Institution of Mechanical Engineers, in the Institution building on Thursday, February 25th, the Captain-elect, Mr. C. W. Myddleton, in the chair. Office bearers for the current year were elected as follows:—President: Sir R. A. Hadfield. Vice-presidents: D. A. Stevenson, E. L. Mansergh, F. J. Walker, S. Price-Williams, W. H. Shortt, E. W. Timmis, K. A. Wolfe Barry, W. L. Mansergh, R. P. Wilson. Captain: C. W. Myddleton. Hon. secretary and treasurer: G. H. Hopewell. Hon. Auditor: S. C. Lewis. Elected members of Committee: W. W. Hughes, P. V. Hunter, R. J. M. Inglis, E. E. Lloyd, E. C. MacKellar, A. D. Mackenzie, H. E. Midgley, E. S. New, C. Stewart.

A NEW VENTILATION AND COOLING SYSTEM.—Readers will still have fresh in their minds the memory of the Flettner rotor ship. The inventor of that device has recently turned his attention to the ventilation of road vehicles, and has produced a ventilator operated by the air current set up by the movement of the vehicle. The rotor is mounted in a suitable position above the roof of the vehicle, and connected by a spindle with a fan which draws the foul air from the interior and delivers it into the atmosphere. The spindle is mounted upon ball bearings, and the rotor being heavy has sufficient inertia to continue to rotate when the vehicle stops to pick up or set down passengers. The makers of the device state that in normal circumstances it will continue to run for about four minutes. Another interesting application of the device is provided by the circulation of the air in refrigeration cars. As in the case of the ventilator, the rotor is mounted above the roof of the car and connected by a spindle supported on ball bearings to an internal fan. Ducts are fitted inside the car into which the air is drawn by the rotor-driven fans. From the delivery side of the fans the air passes through an ice-box or other cooling device, and so out again into the car near floor level. In this way continuous circulation of the air is obtained. Such ventilators and circulators have been fitted to many vehicles on the Continent, and they are now being manufactured in this country by the British Flettner Ventilator and Equipment Company, Ltd., of Norfolk-street, Strand.

THOMAS GRAY MEMORIAL TRUST.—Under the will of the late Thomas L. Gray, the Royal Society of Arts has been appointed residuary legatee of his estate for the purpose of founding a memorial to his father, the late Thomas Gray, C.B., who was for many years Assistant Secretary to the Board of Trade, Marine Department. The objects of the trust are "the advancement of the science of navigation and the scientific and educational interests of the British mercantile marine." The Council now offers the following prizes:—(1) A prize of £100 to any person who may bring to its notice a valuable improvement in the science or practice of navigation proposed or invented by himself in the years 1931 and 1932. Competitors must forward their proofs of claim on or before December 31st, 1932, to the secretary, Royal Society of Arts, John-street, Adelphi, W.C. 2. (2) A prize of £100 for an essay on the following subject: "The rescue by another vessel of passengers and crew of a sinking vessel (a) when they are still on the vessel and while it is still afloat, (b) when they have taken to the boats. Particular attention should be given to improvements which might be effected in life-saving appliances and to the navigation and manœuvring of the rescuing vessel under varying weather conditions." Competitors must send in their essays not later than December 31st, 1932, to the secretary, Royal Society of Arts, at the above address. The essays must be typed in English. They must be sent in under a motto, accompanied by a sealed envelope enclosing the author's name, which must on no account be written on the essay. A breach of this regulation will result in disqualification. Both competitions are open to persons of any nationality, but in the case of the essay competition only, competitors must be past or present members of the seafaring profession. The Council reserves an option on the copyright of the successful essay or essays, but does not claim any rights in respect of any invention to which a prize may be awarded.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	16/6 to 20/–
(1) Spanish	17/– to 21/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	16/6 to 17/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 8 6	—
No. 1 Foundry	3 12 0	—
No. 3 Foundry	3 9 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 4 0	3 4 0
No. 1	3 4 6	3 4 6
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
MIDLANDS—		
(c) Staffs.—	(*Delivered to Station*).	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
" " Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (*a*) 4 0 6 (*b*) 4 5 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	10 10 0	—
Best Bars	11 0 0	—
Double Best Bars	11 10 0	—
Treble Best Bars	12 0 0	—
LANCS.—		
Crown Bars	9 15 0	—
Second Quality Bars	8 5 0	—
Hoops	12 0 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 5 0 to 10 7 6	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 7 6	—
Gas Tube Strip	10 10 0 to 10 12 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	9 0 0	8 10 0
" " (Land)	—	—
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 15 0	7 15 0
Sheets (Gal. Cor. 24 B.G.	10 15 0	10 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
" " (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
" (Small Round)	7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
" (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
" (Lancs. Boiler)	8 12 6 to 8 15 0	—
SHEFFIELD—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	6 0 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
MIDLANDS—		
Small Rolled Bars (all British)	7 5 0 to 7 15 0	—
Small Re-rolled Bars	6 12 6 to 6 15 0	—
Billets and Sheet Bars	5 7 6 to 5 10 0	—
Galv. Sheets, f.o.b. L'pool	9 10 0	—
(2) Staffordshire Hoops	9 10 0	—
(*d*) Angles	8 7 6	—
(*d*) Joists	8 15 0	—
(*d*) Tees	9 7 6	—
(*d*) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 12 6	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14 f.o.b.	16/–
Block Tin (cash)	137 15 0
" (three months)	140 0 0
Copper (cash)	32 6 3
" (three months)	32 15 0
Spanish Lead (cash)	12 8 9
" " (three months)	13 0 0
Spelter (cash)	13 1 3
" (three months)	13 8 9
MANCHESTER—	
Copper, Best Selected Ingots	39 0 0
" Electrolytic	41 0 0
" Strong Sheets	66 0 0
" Tubes (Basis Price), lb.	0 0 10½
Brass Tubes (Basis Price), lb.	0 0 9½
" Condenser, lb.	0 0 11½
Lead, English	14 10 0
" Foreign	12 15 0
Spelter	13 12 6
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/4 per lb.	
Ferro Tungsten	2/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 12 6	7/–
" " 6 p.c. to 8 p.c.	£23 10 0	7/–
" " 8 p.c. to 10 p.c.	£22 15 0	6/6
" " Specially Refined		
" " Max. 2 p.c. carbon	£36 10 0	10/–
" " " 1 p.c. carbon	£43 10 0	12 –
" " " 0·70 p.c. carbon	£52 10 0	13/–
" " " carbon free	11d. per lb.	
Metallic Chromium	3/1 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
" " "	£11 10 0 for export	
" Silicon, 45 p.c. to 50 p.c.	£9 15 0 scale 5/– per unit	
" " 75 p.c.	£15 10 0 scale 7/– per unit	
" Vanadium	12/9 per lb.	
" Molybdenum	6/3 per lb.	
" Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£250 to £255	
Ferro Cobalt	10/– per lb.	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	13/– to 13/3
" " Ell	14/3
" " Splint	14/– to 16/–
" " Trebles	12/6
" " Doubles	10/9
" " Singles	9/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/–
" " Jewel	17/–
" " Trebles	12/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	11/6 to 12/6
Screened Navigation	16/6
Trebles	12/6 to 13/6
Doubles	10/6
Singles	9/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	12/–
Secondary Steam	11/9
Trebles	11/9 to 12/–
Doubles	10/9
Singles	9/6

(8) N.W. COAST— ENGLAND.

Steams	21/9
Household	32/6 to 51/6
Coke	20/6 to 22/6
NORTHUMBERLAND—	
Best Steams	13/6
Second Steams	12/3 to 12/6
Steam Smalls	8/6
Unscreened	12/6 to 13/–
Household	27/– to 39/–
DURHAM—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/– to 37/–
Foundry Coke	24/–

SHEFFIELD—	Inland.	
Best Hand-picked Branch	26/6 to 27/6	—
South Yorkshire Best	22/– to 23/–	—
Derbyshire Best Bright House	22/– to 23/–	—
Screened House Coal	19/– to 20/6	—
Best Screened Nuts	17/– to 18/–	—
Small Screened Nuts	14/6 to 15/6	—
Yorkshire Hards	16/– to 18/–	—
Derbyshire Hards	16/– to 18/–	—
Rough Slacks	8/6 to 9/6	—
Nutty Slacks	7/– to 8/6	—
Smalls	5/– to 6/–	—
Blast-furnace Coke (Inland)	12/– to 12/6 on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b., 18/– to 18/6		

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/– to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 19/–
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/– to 13/6
Ordinary Smalls	11/– to 13/–
Washed Nuts	19/– to 25/–
No. 3 Rhondda Large	19/9 to 20/–
" " Smalls	15/– to 16/–
No. 2 " Large	17/– to 17/3
" " Through	15/6 to 16/–
" " Smalls	14/– to 14/3
Foundry Coke (Export)	22/6 to 26/6
Furnace Coke (Export)	17/– to 18/–
Patent Fuel	19/– to 19/3
Pitwood (ex ship)	20/6 to 22/–
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	36/– to 38/6
Seconds	27/– to 32/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 43/6
Nuts	40/– to 43/6
Beans	28/6 to 32/6
Peas	18/6 to 21/–
Breaker Duff	8/6 to 9/6
Rubbly Culm	8/3 to 8/9
Steam Coals :	
Large	20/– to 20/6
Seconds	18/– to 20/–
Smalls	11/6 to 13/–
Cargo Through	16/– to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate; Joists (minimum), 22/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Engineering Trades.

DURING the past year 300,000 foreign workers are declared to have left the country, and it is officially stated that close upon that number of unemployed are in receipt of out-of-door relief, while the great mass of operatives are not working more than three or four days a week. Most manufacturers are keeping men on as long as they can in view of an early distribution of orders on account of the national programme of public works, while the railway companies must purchase considerable quantities of rolling stock when a vote by Parliament provides them with the financial means of doing so. The national programme seems, nevertheless, to be jeopardised by the financial stringency. All this work can only have a temporary effect upon industrial activity, and when looking to the future the difficulties appear to be almost interminable. The trouble arises from the fact that the engineering industries have been developed too rapidly. Except in a few branches, such as motor cars, manufacturers refused to allow themselves to be drawn into mass production, and, in a general way, French makers are less dependent on foreign trade than others, though export orders are necessary to provide for the fluctuations of the home demand. At first it was hoped to develop that trade with the aid of financial assistance to neutral markets in Central and Western Europe, but even that could not eliminate competition from countries in a better position to supply those markets, and while French capital was accepted the orders, for the most part, went elsewhere. The French are losing their foreign trade because they cannot compete with the Germans, who have invaded their own market to the extent that, during the past three years, the imports of German machinery and metallurgical products into France increased from 800 million francs to 1700 millions and then to 2400 millions. The French do not admit that this increase is a direct result of reparations, and they are only anxious now to protect their own market by means of quotas, while a suggestion has been made that it would be better to transfer superfluous plant to neutral markets like Jugo-Slavia. There is a growing idea that it would be preferable to cut down over-developed factories which can only be run with the aid of imported labour, and to rely more upon the smaller workshops, which have all along maintained themselves by specialisation and are likely to adapt themselves more readily to the changed conditions.

Shipping.

The discomfiture of the Compagnie Générale Transatlantique has awakened national attention to the state of merchant shipping generally, and the Government is now dealing with the matter seriously, its first action being to suppress the Ministry of Merchant Marine and to transfer the services to the Ministry of Public Works. This concentration is intended to avoid the conflicting policies that tend to hinder the reorganisation and control of the companies that receive State subsidies. The Senate has confirmed the advance of 110 million francs by the State for the working of the Transatlantique for six months from January 1st last. The Commission of the Senate has now to examine another proposal to continue work on the ships under construction. With a deficit of 180 million francs for the year 1931, the situation of the "Transat" is regarded as extremely precarious, but every effort will be made to put the company on its feet again under rigid State control, though it is announced that those responsible for the company's failure must be dealt with before the Government introduces its new plan to save the company from bankruptcy. Meanwhile, the other shipping companies claim that drastic measures must be undertaken to protect merchant shipping, which, they say, has been sacrificed to industrial interests by the import quotas, super-taxes, and other restrictions on sea-borne traffic, and they point out that French shipping is placed at a great disadvantage by the application of the eight hours' working day to the mercantile marine as well as by other legislation that increases the charges on shipowners. At the beginning of the year there were 3,568,896 tons of shipping which contributed largely to the national industrial activity, and any neglect of the shipping trade during the present exceptionally difficult period would be disastrous to the country. Therefore shipowners claim that they should receive more assistance from the State, and no doubt the interests of the whole shipping industry will be fully dealt with in the plans which the Government is now preparing for a general reorganisation of those maritime services that are helped by State subsidies.

The Steel Situation.

The chief factor in the iron and steel situation is the attitude of Belgian producers who are making considerable sacrifices to dispose of steel in foreign markets, and are declared to have taken orders for billets in England at £2 7s. 6d. gold per ton, while the price of bars has undergone a further reduction. On account of the difficulty of coming to an agreement amongst themselves, Belgian producers alone stand in the way of the reconstitution of the Steel Cartel. During the past week they held meetings in Brussels in the hope of settling upon quotas, and French representatives were present ready to deal with the question of import quotas for Belgian steel into France in the event of the proceedings terminating satisfactorily; but nothing could break down the exactions of the "outside" producers, and the constitution of the Steel Cartel therefore appears to be as far off as ever. The Belgians continue to insist upon an increased quota of steel production in order to satisfy the claims of the dissentient firms, but neither France nor Germany will give way, so that the steel trade is deprived of the moral effect that might follow upon a Continental agreement to restrict output.

Poland's Navy.

The Government of Poland has taken delivery at Cherbourg of the third submarine constructed by the Chantiers Navals Français. All three are of the same type, displacing 1000 tons at the surface. They have two oil engines, each of 900 horse-power, and two electric motors of 600 horse-power each for propulsion when submerged.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

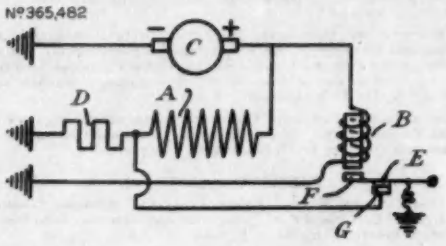
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

365,482. June 26th, 1931.—AUTOMATIC REGULATORS FOR DYNAMO-ELECTRIC MACHINES, Robert Bosch Aktiengesellschaft, of 4, Militärstrasse, Stuttgart, Germany.

This invention relates to automatic regulators for continuous current dynamos of small capacity having a pressure of about 12 volts. The choice of the material for the contacts for these regulators is particularly difficult. Silver oxidises and easily fuses. Tungsten is suitable for pairs of contacts of regulators of dynamos having a voltage of 12 volts and over, but not for dynamos having a lower voltage. According to the invention a contact arrangement is obtained which is entirely satisfactory. The field winding A and the voltage coil B of a dynamo are connected to the positive brush of the armature C, the negative brush

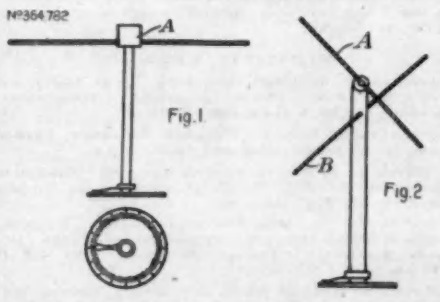


of which is earthed. The resistance D, the end of which, like that of the voltage coil B, is earthed, is connected to the field winding A. The armature E of the regulator is provided with a contact F, which is earthed through the return tension spring. The contact F consists of silver, and lies, in the position of rest of the armature E, against a contact G, which is composed of tungsten and forms the anode. In the position of rest, the pair of contacts E, G are closed and the resistance D thereby short circuited. If the armature of the regulator is attracted at a certain voltage the two contacts F, G are opened, and the resistance D is connected in series with the field winding A. With this contact arrangement it is possible to regulate dynamos having a pressure of 6 volts quite satisfactorily through a regulator having a single pair of contacts.—*January 21st*, 1932.

TELEGRAPHS AND TELEPHONES.

364,782. December 5th, 1930.—DIRECTIONAL RADIO TRANSMITTERS AND RECEIVERS FOR USE ON VERY SHORT WAVES, Telefunken Gesellschaft fur drahtlose Telegraphie, m.b.H., of 12–13, Hallesches Ufer, Berlin, Germany, and Werner Ludenia, of 57, Holsteinische Strasse, Berlin-Steglitze.

The rays proceeding from a rod-shaped dipole radiator are polarised, *i.e.*, radiate substantially only in one plane, so that if transmitting and receiving radiators are arranged parallel to one another a maximum strength is obtained at the receiver, while, if they are mutually perpendicular, a minimum of received strength is obtained. According to this invention this phenomenon is utilised to provide a sharply directional direction-finder suitable for use for navigation. Either or both transmitting and receiving stations are equipped with rod-shaped radiators mounted on a rotating stand so as to be rotatable in a horizontal plane, and scale arrangements are associated with

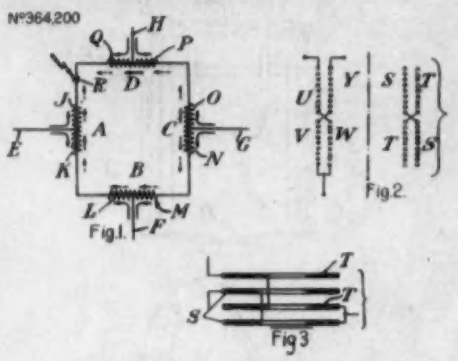


the dipoles to show the position of the angle at any time. Fig. 1 shows an arrangement which may be employed either as a transmitter or as a receiver according to whether an exciter, or a rectifier is connected to the dipole at A. It is, however, more advantageous to provide separate dipoles for transmitting and receiving as shown in Fig. 2, in which the dipoles are shown at A and B. The dipoles are preferably arranged at right angles to each other so that mutual disturbance of the fields is avoided as far as possible. It is also of advantage to arrange a rod-shaped conductor of length equal to half the working wave length parallel to the dipole at a distance of $\frac{1}{2}$, $\frac{3}{4}$, or $\frac{5}{4}$ . . . &c., of the working wave length and arranged to be rotated simultaneously with the dipole. With this arrangement a single position of maximum strength is obtained in a rotation of 360 deg. —*January 14th*, 1932.

TRANSMISSION OF POWER.

364,200. October 9th, 1930.—CHOKING COILS FOR HEAVY CURRENT NETWORKS, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

This specification describes an arrangement of choke coils for limiting fault currents in networks. The diagram, Fig. 1, shows an interconnected network with four feeding points A, B, C, D, to which current is usually fed through the lines E, F, G, and H. At both sides of the feeding points there are the choking coils J and K, L and M, N and O, P and Q, which are arranged in pairs. The individual coils of the pairs are, in normal working, mounted in parallel in relation to the direction taken by the current which can be seen from the arrows in full lines. If, however, at some point of the net—say, for example, at R—a short circuit occurs, then short-circuit currents will flow along the paths shown by the arrows in broken lines, whereby the pairs of coils J and K, L and M, and also P and Q are traversed by current in series. This is the reason for the use of choking coils. In this case, however, the inductive drop in potential, which in normal working is caused by the chokes in the net, must be taken into account, and the object of the invention is to reduce the drop. This is attained by increasing the mutual influencing of the chokes adjacent to a feeding point by arranging the windings of the two chokes one within the other. Two working examples of the invention are shown in Figs. 2 and 3. Fig. 2 shows the construction of two cylindrical

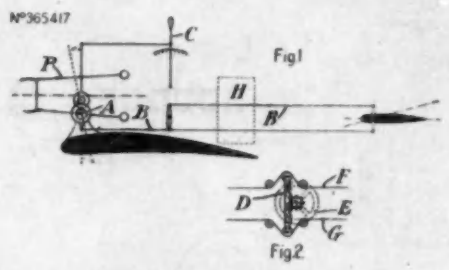


chokes S and T, which are mounted concentrically in relation to each other. Furthermore, the chokes are so subdivided and interconnected that a number of windings U and V of each choke lie in one winding surface, and the other windings W and Y of each choke lie in the other winding surface. This arrangement possesses a special advantage that the self-inductances of the two chokes are equal to each other. Fig. 3 shows the working example for disc-shaped choking coils in which the winding discs of the one coil alternate in axial direction with the winding discs of the other coil.—*January 7th*, 1932.

AERONAUTICS.

365,417. March 31st, 1931.—DEVICES FOR STABILISING AEROPLANES, L. Constantin, 26, rue Eugène-Flachet, Paris, France.

In this machine the elevating rudder is controlled, to keep the main wings at the proper angle, with regard to the wind, by the wind vane P. This vane is mounted on the axis A and operates the rudder through the linkage and wires B B. The vane can be

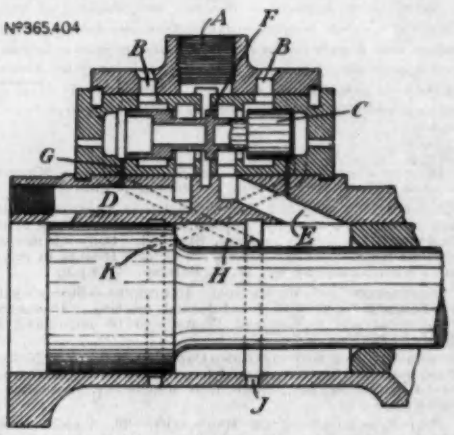


set for any desired elevation by the hand lever C. At H there is the device shown in detail in Fig. 2. By moving the rack D, by means of the hand wheel E, either up or down, the two wires F and G can be shortened or lengthened to adjust the angle of the rudder, with respect to the wind vane, to accommodate changes in the position of the centre of gravity of the machine.—*January 21st*, 1932.

MACHINE TOOLS AND SHOP APPLIANCES.

365,404. March 21st, 1931.—VALVE GEAR FOR ROCK DRILLS, G. H. T. Rayner, 14, Broomhall-road, Sheffield; and P. T. Rayner, 37, Ashland-road, Sheffield.

The air inlet of this drill is shown at A and the two exhaust ports at B B. The valve C controls the inlet of pressure air to the ports D and E by means of the collar F. As shown, the drill piston is at the left-hand end of its stroke and the valve on the right. Air is admitted to the working cylinder by the port D,



and also passes through the fine port G to the back of the valve chamber. The pressure there is, however, lowered through escapement through the passage H and port J. Exhaust from the front end of the cylinder takes place through the port E. At the end of the stroke of the main piston the port K is uncovered, pressure air is admitted to the front end of the valve chamber, the valve is thrown over, and the cycle is repeated.—*January 21st*, 1932.

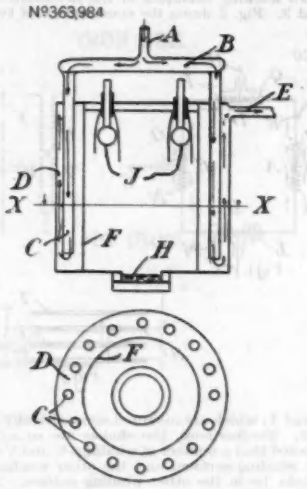
MISCELLANEOUS.

363,984. July 16th, 1930.—MERCURY ARC RECTIFIERS, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2, and Frank Percy Whitaker, of 237, Clifton-road, Rugby.

Several methods of cooling a mercury arc rectifier in accordance with this invention are described and the accompanying

drawings show one of them. The object of the invention is to maintain an even temperature over practically the whole surface of the vacuum chamber and to avoid any part being cooled locally to a temperature corresponding to that of the supply water, even though the temperatures of the inlet and outlet water are widely different. The inlet A leads into a manifold B, from which pipes C extend into the chamber D. These pipes C open

N°363,984

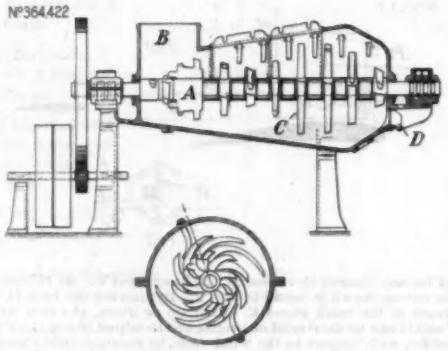


into the lower end of the chamber remote from the outlet E, and are spaced around the chamber F, as will be seen from the lower drawing, which is a section on line X—X. It will be appreciated that cooling water entering at A will pass through a hot region at the upper part of the chamber D, and when it issues at the ends of the tubes C, as shown by the arrows, it will have reached a temperature above that at the inlet A. H is the usual cathode and J the anode.—*December 16th*, 1931.

364,422. March 9th, 1931.—Paper Pulp Machines, W. G. Fraser, Coronation Wharf, Townmead-road, Fulham, London, S.W. 6.

The principal claim in this specification for a shredding machine appears to be connected with the first part of the rotor

N°364422



A, which is described as a worm device for the purpose of ensuring the continuous transfer of the material to be treated from the feed hopper B to the beater arms C. The form of these beaters is shown in the end section. The outlet for the pulped material is marked D.—*January 7th*, 1932.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Tuesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institute of Marine Engineers.—85–88, The Minories, London, E.C. 3. Annual General Meeting. 6 p.m.

Institute of Metals: Sheffield Local Section.—In the Non-ferrous Section of the Applied Science Department of the University, St. George's-square, Sheffield. Conjoint meeting with Sheffield Technical Trades Society. "Defects in Spoon and Fork Blanks," by Mr. W. R. Barclay. 7.30 p.m.

Institution of Mechanical Engineers.—Storey's-gate, St. James's Park, S.W. 1. Informal meeting. Discussion, "Industrial and Commercial Waste," to be introduced by Mr. J. L. Hodgson. 7 p.m.

Institution of Municipal and County Engineers: North-Western District.—Visit to Irlam Works of the Lancashire Steel Corporation, Ltd., Irlam, near Manchester. Assemble at works 12.15 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. "The Preparation of Commercial Copper from its Ores," by Mr. T. J. Taplin. 7.30 p.m.

Physical Society.—At the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. 7. "A Vacuum Calorimeter for High Temperatures," by Messrs. L. G. Carpenter and T. F. Harle; "A New Tilted Electrometer," by Mr. Hugh Carmichael; "The Symmetrical Modes of Vibration of Truncated Conical Shells with Applications to Loud-speaker Diaphragms," by Dr. N. W. McLachlan; a demonstration on some lecture experiments in alternating currents will be given by Mr. Wm. Bennett. 5 p.m. Editing Committee meeting, 3.30 p.m.; Council meeting, 4 p.m.

Railway Club.—57, Fetter-lane, E.C. 4. Lecture, "200 m.p.h.," by Mr. D. V. Levien. 7.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Michael Faraday and Electro-chemistry," by Sir Harold Hartley. 9 p.m.

TO-DAY and SATURDAY, MARCH 5th.

British Industries Fair, 1932.—Castle Bromwich, Birmingham, To-day; White City, To-day and March 5th.

SATURDAY, MARCH 5th.

Institute of British Foundrymen: Lancashire Branch.—At the College of Technology, Sackville-street, Manchester. "Some Notes on the Centrifugal Castings Process," by Mr. J. E. Hurst. 3.30 p.m.

Institution of Electrical Engineers: North Midland Students' Section.—Visit to the Thorpe Stapleton Sewerage Works of the Leeds Corporation. Meet outside the General Post Office, City-square, Leeds, at 2.15 p.m.

SUNDAY to SUNDAY, MARCH 6th to 13th.

Leipzig Spring Fair, 1932.—General Sample Fair, March 6th to March 12th; Engineering and Building Fairs, March 6th to March 13th; Textile Fair, March 6th to March 9th. Open daily.

MONDAY, MARCH 7th.

Chartered Surveyors' Institution.—12, Great George-street, S.W. 1. "Causes, Consequence and Cure of Damp in Buildings," by Mr. R. Fitzmaurice. 8 p.m.

Institution of Electrical Engineers: North Midland Students' Section.—Visit to the works of the Yorkshire Fure Ice and Cold Storage Company. Meet at Leeds Corn Exchange, 7.15 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Howard Lecture. "Oil Engine Traction," by Mr. Alan E. L. Chorlton. 8 p.m.

Society of Chemical Industry.—Joint Meeting. An inaugural meeting of the newly formed Food Group will be held jointly with the London Section in the Chemical Society's rooms, Burlington House, W. 1. Discussion, "Science and Food," by Dr. L. H. Lampitt. 8 p.m.

Wolverhampton and District Engineering Society.—The Victoria Hotel, Wolverhampton. "Steam Generation in Factories," by Mr. H. E. Partridge. 7.30 p.m.

TUESDAY, MARCH 8th.

Institute of Marine Engineers.—The Minories, London, E.C. 3. "Pulverised Fuel Firing with special reference to Power Station Practice," by Mr. S. B. Jackson. 6 p.m.

Institute of Metals: Swansea Local Section.—At the Y.M.C.A., Swansea. "Metallography in Industry," by Mr. Roosevelt Griffiths. Also annual general meeting. 6.15 p.m.

Institution of Automobile Engineers.—King's Head Hotel, Coventry. "Motor Cycle Progress: Past, Present, and Future," by Captain H. D. Teage. 7.30 p.m.

Institution of Civil Engineers.—Great George-street, S.W. 1. Discussion, "The Electrification of the Madras Suburban Section of the South Indian Railway," by Mr. B. G. White. 6 p.m.

Institution of Civil Engineers, Institution of Mechanical Engineers, Institution of Electrical Engineers: Midland Graduate and Student Sections.—Midland Hotel, Birmingham. The Annual Joint Meeting. A representative of each Institution will read a short paper on the subject of "Have Engineers Made the Best Use of Natural Power?" which will be followed by a discussion. 7 p.m.

Institution of Petroleum Technologists.—At the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. Presidential Address by Mr. J. Kewley. 6.15 p.m.

Institution of Electrical Engineers.—39, Elmbank-crescent, Glasgow, C. 2. Scottish Centre. "Recent Developments at Yoker Power Station," by Mr. N. C. Bridge. 7.30 p.m.

Institution of Engineers and Shipbuilders in Scotland.—39, Elmbank-crescent, Glasgow, C. 2. "Recent Improvements and Reconstruction Works in Glasgow Harbour," by Mr. A. C. Gardner. 7.30 p.m.

Manchester Geological and Mining Society.—Queen's Chambers, 5, John Dalton-street, Manchester. "Mountain Mines in Lancashire," by Mr. L. H. Tonks and Mr. R. C. B. Jones. 4 p.m. The Council will meet at 3 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, W. 1. "Detonating Substances," by Professor W. E. Garner. This lecture and the one which should have been given on March 15th have been cancelled owing to a serious accident to Professor Garner.

WEDNESDAY, MARCH 9th.

Institution of Civil Engineers.—Great George-street, Westminster, S.W. 1. Students' meeting. "Foundations for Buildings," by Mr. F. Breakwell. 6.30 p.m.

Institute of Metals.—Trocadero Restaurant, Piccadilly-circus, W. 1. Annual dinner and dance. 7 p.m.

Institution of Engineers-in-Charge.—St. Bride Institute, Fleet-street, E.C. 4. "The Development of the Thermionic Valve," by Mr. F. E. Henderson. 7.30 p.m.

Institution of Municipal and County Engineers: North-Western District.—At the Engineers' Club, Albert-square, Manchester. "Transport Problems," by Mr. N. E. Box. 6.45 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. "Afforestation Work in the Central Plateau of France," by Professor Edward P. Stebbing. 8 p.m.

WEDNESDAY and THURSDAY, MARCH 9th and 10th.

Institute of Metals.—In the Hall of the Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Twenty-fourth annual general meeting. Reading and discussion of papers. For programme see page 137.

THURSDAY, MARCH 10th.

Institute of British Foundrymen: Lancashire Branch: Burnley Section.—In the Municipal College, Ormerod-road, Burnley. Annual general meeting. Discussion, opened by Mr. John Jackson. 7.15 p.m.

Institute of Marine Engineers: Junior Section.—The Minories, E.C. 3. Debate: "Steam *versus* Diesel Machinery for Marine Propulsion," openers, Mr. H. R. Tyrrell and Mr. E. W. Cranston. 7 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C. 2. "Modern Boiler Plant," by Mr. J. Bruce. 6 p.m.

Institution of Mechanical Engineers: Yorkshire Branch.—Hotel Metropole, Leeds. "Testing of Materials for Service in High-temperature Steam Plant," by Mr. R. W. Bailey and Mr. A. M. Roberts. 7.30 p.m.

Institution of Municipal and County Engineers: South Midland District.—Visit to works of George Kent, Ltd., Luton. 11 a.m. Visit to works of Skefko Ball Bearing Company, Ltd. 2.30 p.m.

Institution of Structural Engineers.—10, Upper Belgrave-street, S.W. 1. "Tolerances and Clearances in Structural Steel Work," by Mr. J. Stuart Lewis. 6.30 p.m.

Stephenson Locomotive Society.—At Headquarters, King's Cross. "Some Factors Affecting the Riding of Coaching Stock," by Mr. A. J. Dymond. 6.30 p.m.

FRIDAY, MARCH 11th.

Association of Ex-Siemens Men.—Gatti's Restaurant, King William-street, Strand, W.C. 2. Smoking concert. Particulars from Mr. J. Snow Huddleston, Dagenham Dock, Essex.

Institution of Electrical Engineers: North Midland Centre.—Hotel Metropole, Leeds. Annual dinner. 7 p.m. for 7.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. "The Manufacture of Large Astronomical Telescopes," by Mr. Cyril Young. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—At the Mining Institute, Newcastle-upon-Tyne. "Some Notes on Steel Shipbuilding," by Mr. N. M. Hunter. 6 p.m.

SATURDAY, MARCH 12th.

Finsbury Technical College Old Students' Association.—At the Trocadero Restaurant, London, W. 1. Annual dinner. Particulars and tickets may be obtained from Mr. F. R. C. Rouse, 15, Clifton-gardens, Golders Green, N.W. 11.

Royal Institution of Great Britain.—21, Albemarle-street, W. 1. "The Electron," by Lord Rutherford. 3 p.m.

MONDAY, MARCH 14th.

Institute of Metals: Scottish Local Section.—In the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Some Notes on Condenser Tubes and their Packing," by Mr. J. Stirling; "Non-ferrous Alloys in Marine Engineering: Some Recent Developments," by Dr. J. W. Donaldson. Also annual general meeting. 7.30 p.m.

Institution of Mechanical Engineers.—Storey's gate, St. James's Park, S.W. 1. Graduates' Section. Annual Lecture. "The Strength and Behaviour of Steels at High Temperatures," by Dr. W. H. Hatfield. 6.45 p.m.

Institution of Railway Signal Engineers.—Joint meeting with the Institute of Transport, at the Institution of Electrical Engineers, Victoria Embankment, W.C. 2. "Railway Colour Light Signalling in relation to Manual Block and Multiple-aspect Signals," by Mr. A. F. Bound. 5.30 p.m.

TUESDAY, MARCH 15th.

British Association of Refrigeration.—At the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, London, S.W. 1. "The Ditton Laboratory: (1) Gas Storage Investigations, (2) Experimental Hold," by Dr. Cyril West and Dr. A. J. M. Smith. 5.30 p.m.

Institute of Metals: North-East Coast Local Section.—In the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. "Refining of Copper," by Mr. R. D. Burn. Also annual general meeting. 7.30 p.m.

Institution of Automobile Engineers.—Engineering Club, Queen-street, Wolverhampton. "Motor Cycle Progress: Past, Present, and Future," by Captain H. D. Teage. 7.30 p.m.

TUESDAY, MARCH 15th, to THURSDAY, MARCH 24th.

Holland's Industries Fair.—At Utrecht, Holland. Open daily.

WEDNESDAY, MARCH 16th.

Institution of Civil Engineers.—Great George-street, Westminster, S.W. 1. Discussion, "Possibilities of Reducing Heat Losses in Circulating Water in Power Stations," by Mr. I. V. Robinson. 6 p.m.

Institution of Naval Architects.—Grand Hall, Connaught Rooms, Great Queen-street, Kingsway, London, W.C. 2. Annual Dinner. 7.30 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. "Hydrogen and its Uses," by Dr. E. Frankland Armstrong. 8 p.m.

WEDNESDAY to FRIDAY, MARCH 16th, 17th and 18th.

Institution of Naval Architects.—In the Lecture Hall, Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Seventy-third Annual Meeting. For programme see page 270.

THURSDAY, MARCH 17th.

Institute of Metals: Birmingham Local Section.—In the Chamber of Commerce, New-street, Birmingham "The Extrusion of Metals," by Mr. R. Genders. 7 p.m.

Institute of Metals: London Local Section.—In the Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W. 1. "The Efficacy of Testing Methods," by Dr. H. J. Gough. 7.30 p.m.

THURSDAY to SATURDAY, MARCH 17th to 19th.

Institution of Municipal and County Engineers.—Scottish District meeting at Ayr.

FRIDAY, MARCH 18th.

Institution of Mechanical Engineers.—Storey's-gate, S.W. 1. "The Machinability of Steel as Indicated by its Macrostructure," by F. E. Robinson and C. T. Nesbitt. 6 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Informal debate on engineering topics. 7.30 p.m.

SATURDAY, MARCH 19th.

Keighley Association of Engineers.—Queen's Hotel, Keighley. Annual Dinner; reception, 5.45 p.m.

MONDAY, MARCH 21st.

Institution of Automobile Engineers.—At the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Motor Cycle Progress: Past, Present, and Future," by Captain H. D. Teage. 7.30 p.m.

TUESDAY, MARCH 22nd.

Institution of Electrical Engineers: Scottish Centre.—North British Station Hotel, Edinburgh. "Commercial Cooking by Electricity," by Dr. T. Settle. 7 p.m.

WEDNESDAY, MARCH 23rd.

Institution of Automobile Engineers.—Hotel Metropole, King-street, Leeds. "The Possibilities of the Unorthodox," by Mr. Maurice Platt. 7.15 p.m.

THURSDAY, MARCH 31st.

Institute of Marine Engineers.—The Minories, E.C. 3. Lecture, "The Salvage of ex-German War Vessels at Scapa Flow," by Mr. E. F. Cox. 7 p.m.

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